THE

PRINCIPLES AND PRACTICE

OF

MEDICAL JURISPRUDENCE

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PREFACE.

ır preparing this work for a Second Edition, it has been found ecessary to divide it into two volumes. Every page has underone revision, and such alterations and additions have been made s the progress of time had rendered necessary. A slight change as been made in the arrangement of the subjects, and this has een accompanied by an increase in the number of the chapters rom eighty-seven to one hundred. Some cases of old date have een omitted, and replaced by others of more recent occurrence nd of more immediate interest.

The subject of MEDICAL EVIDENCE has been enlarged, and inorporated in two chapters with the text of the work. In the ection on POISONING, in addition to recent cases and improved rocesses of analysis, notices of several new Poisons have been inoduced. In the section on WOUNDS and PERSONAL INJURIES, any new cases of medico-legal importance will be found, and ere have been considerable additions to the chapters on Wounds the Throat and Chest, on Blood-stains, and the new methods of earch proposed for the detection of blood, including Spectral alysis and the Guaiacum process. The subject of Cicatrices and er marks indicative of personal identity has acquired great o-legal interest in reference to the *Tichborne Case.* The nce derivable from these marks will be found in the chapter priated to this subject; but as the case is still pending, it is sible to give a summary of the medical evidence or to make omments upon it. Additions of facts and new cases have made to the chapters on death from ASPHYXIA, on death from ATION, including the case of the *Welsh Fasting Girl,* also to

the chapters on CRIMINAL ABORTION, INFANTICIDE, INSANITY, and LIFE INSURANCE. From the large number of medico-legal cases published yearly in British and Foreign journals, it has been found impossible to refer to more than a selection of them, and to condense the details as much as possible. In spite of the increased dimensions of the work and its publication in two volumes, it has been considered advisable to confine it within certain limits, and to insert notices of those cases only which appeared to have some immediate and practical interest for medical men and lawyers. When it has been found impossible for want of space to quote a case fully, numerous references have been inserted, showing where additional information may be obtained. Some new engravings from photographs and original drawings have been introduced into these volumes.

I have in conclusion to express my obligations to many known as well as unknown correspondents in the professions of Law and Medicine, for the reports of numerous cases not before published, which I have been able to introduce into this edition. I have also to thank others for their friendly criticism on some parts of the first edition. It will be seen that I have taken advantage of their suggestions.

A. S. T.

15 ST. JAMES'S TERRACE, REGENT'S PARK
August 1873.

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CORRIGENDA.

Vol. I. at page 216. *Sulphuric Acid. On the throwing of corrosive fluids.* Under the Criminal Law Consolidation Act it is enacted that whosoever shall cast or throw at, or upon, or otherwise apply to any person any corrosive fluid with intent to burn, maim, disfigure, or disable any person, or to do some grievous bodily harm, shall, whether any *bodily injury be effected or not*, be guilty of felony, and punished accordingly. A chemical examination of the clothes may furnish the only evidence of the corrosive nature of the fluid.

" " 275, 27th line from foot, insert vol. 2, after 1867.

" " 311, 22nd line from foot. In reference to the case of *General Ketchum*, it is stated in the text that 'but for the alleged discovery of twenty grains of tartar emetic in the stomach after death, no suspicion of poisoning would have probably arisen.' Dr. P. C. Williams, of Baltimore, informs me that this is an error. Poisoning was suspected during life, and a post-mortem examination was made on account of this suspicion. It does not appear, however, that the urine was analysed while the patient was living. This would have truly shown whether the patient was suffering from antimonial poisoning or not, and it would have confirmed or removed the suspicion. Under any circumstances the objections to the chemical analysis remain unanswered. If the metal antimony had been detected in the urine when the suspicion of poisoning first arose, the case would have assumed a very different aspect.

" " 312, 31st line from foot, in place of the words 'detecting antimony when mixed with arsenic' read 'detecting arsenic when mixed with antimony.'

" " 541, 5th line from top, for the 'orange-yellow' read 'the orange, the yellow.'

" " 593, 10th line from top, for 'Dr. Wilk's observations' read 'Dr. Wilks's.'

" " 595, top line, for 'innoculation' read 'inoculation.'

" " 640, misprinted 460

" " 683, 21st line from foot, for 'Dr. Smith' read 'Dr. Swift.'

THE

PRINCIPLES AND PRACTICE

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MEDICAL JURISPRUDENCE.

MEDICAL EVIDENCE.

CHAPTER 1.

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THE PRACTICE OF MEDICAL JURISPRUDENCE—MEDICAL AND MEDICO-LEGAL DUTIES CONTRASTED—MEDICAL REPORTS—CORONERS' INQUESTS—CONCEALED MURDERS—INSPECTIONS OF THE DEAD—TRIAL AT THE ASSIZES—SUBPŒNAS—DUTIES AND PRIVILEGES OF MEDICAL WITNESSES.

MEDICAL JURISPRUDENCE—or, as it is sometimes called, FORENSIC, LEGAL, or STATE MEDICINE—may be defined to be that science which teaches the application of every branch of medical knowledge to the purposes of the law; hence its limits are, on the one hand, the requirements of the law, and on the other, the whole range of medicine. Anatomy, physiology, medicine, surgery, chemistry, physics, and botany, lend their aid as necessity arises; and in some cases all these branches of science are required to enable a Court of Law to arrive at a proper conclusion on a contested question affecting life or property.

Medical jurists are by no means agreed upon the exact boundaries of their science. Some authorities include forgery and coining, and all offences requiring purely chemical evidence; others include feigned diseases, nuisances, and subjects connected with public health or sanitary legislation; while one German writer introduces the government and regulation of Temperance societies. Those who thus propose to enlarge the science forget the maxim, '*Ars longa, vita brevis*;' and they also forget that, by demanding too much of a medical practitioner, they may deter him from undertaking the study of that portion which may really prove serviceable to him in the practice of his profession.

The purpose of this work is to bring as far as possible within a reasonable compass those subjects which especially demand inquiry, and which more particularly concern the duties of the educated physician and surgeon. The definition above given necessarily implies that a medical jurist should have a theoretical and practical knowledge of all branches of the profession, a large range of experience, and the rare power of adapting his knowledge and experience to emergencies. He should be able to elucidate any

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difficult medico-legal question which may arise, and be prepared at all times to make a cautious selection of such medical facts, and a proper application of such medical principles, as may be necessary to enable a judge to place the subject in an intelligible light before the jury, and to enable a jury to arrive at a just conclusion.

Medico-legal knowledge does not consist so much in the acquisition of facts as in the power of arranging them, and in applying the conclusions to which they lead to the purposes of the law. A man may be a most skilful surgeon, or a most experienced physician; his mind may be well stored with professional information; yet if he is unable by the use of simple language to make his ideas known to others, his knowledge will be of no avail. One far below him in professional standing and experience may make a better medical witness.

The variety of subjects in which a medical jurist is required to have knowledge and experience may alarm a student of medicine, and lead him to suppose that, as he cannot make himself perfectly acquainted with all, he may well forego the labour of preparing himself in any. But this would be taking an erroneous view of his position. This description of the qualifications necessary to constitute a normal witness in a Court of Law must not deter him from entering on the study. It is assuredly beyond the mental power of any individual that he should be at the same time profoundly versed in all the principles of medicine and jurisprudence, and that he should be able to answer all possible questions, and encounter and remove all medical difficulties that may occur during the trial of a civil or criminal case. All that the law expects from a medical man is a fair average knowledge not merely of his profession, but of that which falls more peculiarly under the province of a medical witness. There can be no doubt that the more perfectly a man has made himself master of his profession, the better will he be fitted to follow the principles and apply himself to the practice of medical jurisprudence; but he must divest himself of the notion that these principles can be spontaneously acquired, or that they are necessarily derived from the study of those isolated branches of medicine upon which medical jurisprudence is based. The materials for the medical jurist undoubtedly exist in these collateral sciences: but they require to be assorted, selected, and moulded into shape, before they can be applied to any useful purpose. A man may be well qualified to practise as a physician or surgeon, and yet find himself deficient when called upon to act as a medical witness. There was no doubt that John Hunter stood in his time at the very head of his profession, and that none could have profited more by industry and experience. If sound professional knowledge could have qualified any man to act as a medical witness, we should assuredly be justified in pointing to him as an example; and yet this great man, when summoned to give evidence on a memorable trial for poisoning, which occurred in 1781, was obliged to confess that he was unable to give a satisfactory answer to the important question put to him. John Hunter was the only professional witness called on the part of the prisoner to rebut the charge of poisoning the deceased by laurel water. His cross-examination, however, rather strengthened the case for the prosecution; and the final question put by the Court was: 'Give your opinion in the best manner you can, one way or the other, whether, upon the whole of the symptoms described, the death proceeded from the medicine (laurel water), or any other causes?' *A.* 'I do not mean to equivocate; but when I tell the sentiments of my own mind, what I feel at the time, I can give nothing decisive.' With that candour which exists in all great minds, John Hunter admitted his deficiencies; and he regretted to the latest period of his life that he had not directed more attention to subjects of this nature. It is perfectly clear from

his answer that he should not have appeared in the case at all. In John Hunter's time Medical jurisprudence was unknown; but the want of it was clearly perceived. It was made apparent from the events of this remarkable trial (*Rex* v. *Donellan*, Warwick Lent Assizes, 1781), that a peculiar kind of experience was required to fit a medical man to act as a witness in a Court of Law—that many loose principles existed in medicine, surgery, and chemistry, the fallacies of which were quite unimportant so far as they related to medical practice, but which required to be closely sifted and thoroughly examined before they could be received as evidence in law. Medical men were then, as now, apt to confound what is mere matter of belief with proof. In a Court of Law, however, the difference is soon made apparent. From the occurrence of this and similar cases, there was an obvious necessity for the creation of a distinct branch of science in which all medical facts and principles capable of serving as evidence should be arranged, developed, and explained.

The duties of a medical jurist are distinct from those of a physician or surgeon: the latter looks only to the treatment of disease or accident, and the saving of life; but the object of the former, in a large proportion of cases, is, whether in reference to the living or dead, to aid the law in fixing on the perpetrator of a crime, or to rescue an innocent person from a falsely imputed crime. Thus he may be required to determine whether, in a particular case, the cause of death is natural or violent; and for this purpose it will be necessary for him to make an entirely new application of his professional knowledge. He has now the difficult task of making a selection from those parts of the medical sciences which bear upon the legal proof and development of crime.

Some members of the medical profession have been inclined to look upon medico-legal practice as an unnecessary addition to their ordinary duties; but there are few who have been long engaged in the practice of the profession who have not found themselves occasionally placed in situations of difficulty from the accidental occurrence of cases demanding medico-legal investigation. A medical man is summoned to attend a person labouring under the effects of poison criminally administered, but at the time he may have no knowledge or even suspicion that poison is the cause of the symptoms. In spite of the best treatment, death ensues: here the functions of the medical man end, and those of a medical witness begin. It is utterly impossible that he can now avoid giving evidence, or shift the responsibility on another—the law will insist upon his appearance, first in the Court of the coroner, and afterwards at the Assizes. It will here be assumed that as a registered member of the profession he is fully competent to answer every question put to him by judge and counsel relative to the general effects of poison; the quantity of each required to destroy life; and the time within which a poison may prove fatal. It may be objected to his evidence, that the deceased had died from the effects of disease and not from poison; in which case the cross-examination will lead to a searching inquiry into all those diseases which resemble poisoning in their symptoms and post-mortem appearances, as well as the means of making a certain distinction between them, and the fallacies to which the chemical processes for the detection of poison are liable. On another occasion, a medical man may be called to render assistance to one who has been stabbed in a quarrel, and who speedily dies from the wound. The office of the surgeon here ceases, while that of the medical jurist commences. He must now be prepared to answer numerous questions, all bearing upon the legal proof of crime—all necessary in law, although apparently superfluous in surgery. Thus he may be asked to state the precise characters of a wound inflicted upon the body of a man soon after death, and by what means a particular

wound was inflicted. Was it homicidal or accidental? The amount of blood lost? Whether the person could have moved or performed any act after receiving it? Are certain red stains found upon his clothes, or upon a knife belonging to him, owing to effused blood or other causes? Whether any and what statements were made by the dying man, and what were the precise circumstances under which they were made? It need hardly be observed that questions of this nature are rarely noticed, except in a cursory manner, by professors of chemistry and surgery, and a medical man is not likely to acquire the means of answering them by intuition. On the other hand, regarding ourselves as living in a civilized state, in which the detection and punishment of crimes against life and property are indispensable to the security to all, it is impossible to overrate their importance. Unless a witness is able to return answers to these questions when a public necessity occurs, a guilty man may escape punishment or an innocent man may be condemned. He may thus most seriously injure his own reputation; for it is certain that his qualifications as a physician, surgeon, or general practitioner, however great, will not shield him from the reproach of having caused a failure of justice.

Thus, then, it is obvious that the duties of a medical jurist are of a highly responsible nature and of great importance to society, while the cases which call them into exercise are of purely accidental occurrence. A medical practitioner who thinks himself secure in the most retired corner of the kingdom, is liable to find himself suddenly summoned as a witness on a trial, to answer questions which perhaps during a long period of practice he had been led to regard as trifling and unimportant. Under the circumstances it is scarcely possible that he can avoid exposing his deficiencies, and the final question will be, *Have you ever attended to or thought of these subjects before?* A negative answer to this question, while it commonly brings with it public censure, will in most instances lead to the acquittal of the accused in spite of strong presumptions of guilt.

I have endeavoured to avoid overdrawing this picture; its truth will, I am sure, be felt and acknowledged by those who have been a few years engaged in practice. The records of our law-courts contain many unfortunate exposures, which might have been easily avoided, had the witnesses only availed themselves of the opportunities afforded to them of acquiring a knowledge of the subject; but they had unreflectingly acted on the principle that medical jurisprudence was a dry, dull, and useless study, and that the practice of it was remote and speculative. This feeling is, however, fast disappearing. Those who have been compelled by circumstances to give their attention to it, have in subsequent cases taken care to prepare themselves for the ordeal through which every medical witness must pass.

Some medical men who have treated legal medicine with indifference have occasionally ventured to act as witnesses, thinking that the subjects on which they were likely to be examined were so little known to judge and counsel, that even hazardous or rash statements would escape observation: such witnesses, however, have often found to their cost that they were labouring under a great delusion. Various circumstances have led, in recent times, to the acquisition of much medico-legal knowledge by lawyers, especially in relation to questions connected with wounds, child-murder, and poisoning; and they are not slow in detecting and exposing a mere pretender who attempts to shelter himself by vague or evasive statements and technical language. There are few counsel engaged in any civil or criminal case of importance who do not take care to fortify themselves, under medical advice, with a full knowledge of the views of standard medical writers on the subject in dispute; and with these works before them, and with their proverbial acuteness, he

must indeed be a clever witness who can now succeed in passing off an erroneous or evasive answer to a medico-legal question.

It is a frequent charge against members of the medical profession, that in a Court of Law they are the worst witnesses on matters of fact and opinion. I believe this to be an unmerited censure. Those who are ready to make this charge overlook the complexity and difficulty of the questions which are put to medical men compared with those put to other witnesses. They also forget that medical men are much more frequently summoned as witnesses than the members of the two other learned professions. Their evidence obtains much greater publicity, and is necessarily exposed to greater criticism. I was, on one occasion, present at a trial before the late Lord Truro, in which the action was between two members of the legal profession, and the witnesses on both sides were chiefly barristers, solicitors, or solicitors' clerks. The questions put to the witnesses were so cleverly met and so technically evaded, that it was scarcely possible to obtain a plain statement or a consistent history of the most simple facts of the case. A direct answer could not be procured on any question, and the mode in which the witnesses gave their testimony elicited on several occasions rebukes from the learned judge. The fact is, that good and bad witnesses are to be met with in every profession; under equal conditions there is no reason to suppose that one would furnish a greater number of incompetent witnesses than another. It is certainly the fault of medical men that they are not generally prepared for the questions which are likely to arise in a case on which they know they will be required to give evidence. This want of preparation frequently applies to facts as well as to opinions. Thus, in reference to a case on which a charge of murder or manslaughter may be ultimately founded, a medical man who is called in, frequently omits to observe many circumstances because they appear to him to be irrelevant or to have little importance, although at the subsequent trial he may find, to his dismay, that they actually become the turning-points of innocence or guilt. Medical observation as a result of professional habits is, on these occasions, in general confined to only one set of circumstances—the recognition and treatment of disease or personal injury; but medico-legal observation should take a much wider range than this, and should be directed to all the surrounding facts and incidents of a case. The essential difference in the two kinds of practice is, that circumstances which are of no interest in a medical or surgical point of view are often of the greatest value and importance in legal medicine. It is obvious that if they are not observed by a medical witness when he is first summoned to the injured person, whether dying or dead, it will be out of his power to meet many of the questions which must arise in the progress of the case. The non-observance of these facts is a serious evil, and often carries with it, although unjustly, an imputation of professional ignorance.

The first duty, therefore, of a medical jurist is to cultivate a faculty of minute observation of medical and moral circumstances. This, when combined with a general knowledge of what the law requires as evidence, will enable him to meet in a satisfactory manner all the scientific questions that may be necessary for the elucidation of a case. The exercise of this faculty is by no means inconsistent with the performance of his duties as a surgeon. Some eminent professional men have been known to possess this power as a natural gift. I have elsewhere given a short notice of a case which occurred to the late Sir Astley Cooper. He was called to see a man who, while sitting in his chair in a private room, had been mortally wounded by a pistol-shot from the hands of an unseen person. Sir Astley having done what was necessary respecting the wound, compared closely the direction from which the pistol was fired with the position of the wounded man, and he came to

the conclusion that the pistol must have been fired by a left-handed man. The only left-handed man known to be on the premises at the time was an intimate friend of the deceased, against whom there was no suspicion; but this acute observation led to his arrest and trial, and he was subsequently convicted of this act of murder.

The condition and position of the body of a person dead from wounds, the position of a weapon, and the state of the dress and weapon, as well as the form and direction of the wound itself, are not always noticed with sufficient accuracy. It is, however, only right to say that many medical men in the present day show great acumen in their examination of these cases. I was present at a trial for murder in which the evidence showed that a man had been stabbed in the chest, and he died almost instantly from a wound in the heart. The act had been perpetrated by some one in a crowd in the dusk of the evening, but no one was seen to strike the blow, and no weapon was found near the spot. The surgeon observed that the wound in the chest was sharp at one angle and rounded at the other, and he gave his opinion that the wound had been inflicted with a knife having one sharp edge, and not with a dagger or double-edged knife. Within a few hours after the occurrence, a man was arrested on suspicion and a knife which he attempted to conceal was taken from him. It was in a sheath, and had at this time *wet* blood upon it, showing a recent use of the weapon. It was a pointed knife, with a broad blade, and one sharp edge only—such a weapon as, in the opinion of the surgeon, would have produced the stab in the chest. The man was tried and convicted, the observation of the surgeon respecting the state of the wound and the weapon furnishing important evidence of his guilt. On the other hand, want of observation may lead to the discharge of guilty persons. I have elsewhere noticed a trial for murder which took place in Scotland. A woman was found dead in her bed, with some lacerated wounds of the scalp: there was strong reason to believe that these had been produced by criminal violence, but it was suggested for the defence that as there were projecting nails at the head of the bed, these lacerations might have arisen from accident—a suggestion supported to some extent by the medical evidence. An experienced witness, however, stated that from his examination he did not believe that the nails, even if they were in the bedstead at the time of the occurrence, could have produced the wounds. He also said that as blood had issued from the wounds, and there was no blood about the nails or this part of the bed around them, he did not believe that the head had at any time come in contact with the nails. Those who were first called to the dead body had omitted to notice whether there was anything on or near to the bed to account for the wounds on the scalp, and they were quite unable to say whether there were or were not any projecting nails at the head of the bed when they first examined the body. The prisoner was discharged on a verdict of 'Not proven;' and there was some reason to believe that he escaped through manufactured evidence, *i.e.* that the nails had been driven into the head of the bed subsequently to the death of the woman. At any rate, it seems perfectly clear from a general view of the medical evidence, that the wounds could not have been produced by the nails in the manner suggested, and that the wounded portion of the scalp had not at any time been in contact with them. As they were lacerated wounds, and so might have been produced by nails, the accused had the benefit of the doubt which was thus raised in the minds of the jury.

The learned judge who tried this case remarked that '*a medical man, when he sees a dead body, should notice everything.*' Undoubtedly he should observe everything which could throw a light upon the production of wounds or other injuries found upon it. It should not be left to policemen to say

whether there were any marks of blood on the dress or on the hands of the deceased, or on the furniture in the room. The dress of the deceased as well as the body should be always closely examined at once on the spot by a medical man. The importance of this precaution is well illustrated by a case related in another page, in which a man just escaped committal on what would have proved a false charge of murder, by reason of the examination of an article of dress accidentally produced at the adjourned inquest.

There is another point which is frequently omitted on these occasions, and the omission may give rise to great inconvenience if not to a failure of justice. Thus, in reference to a dead body, no observation is made at the time of the visit whether it or any part of it is cold or warm; whether the limbs are cold and rigid, or cold and pliant. In a medical and surgical view these conditions of the body are of no importance whatever, but medico-legally, if the facts are observed, they may enable a witness to speak with greater or less probability on the time of death: this may make all the difference between the acquittal and conviction of a person charged with murder. The case of *Gardner*, elsewhere related, will show the importance of observations of this kind. The circumstances which chiefly require notice on these occasions have been fully described in the section on Wounds. In reference to supposed death from poison, other matters will also require special attention. These will be found in detail in the chapters on Poisoning.

It may stimulate the attention of a medical practitioner in reference to these inquiries, if he is informed that the great art of counsel who defend persons charged with murder or manslaughter consists in endeavouring to discover what he omitted to do. Although sometimes the omission may be really of no medical importance whatever, yet it is usually placed before the jury in such a strong light that the accused obtains the benefit of a doubt. The omission may be attributed to professional ignorance, or, what is worse, to professional bias—a determination to find proofs of guilt against the 'unhappy prisoner at the bar'—when the facts might be innocently explained by a want of experience on the part of the witness in dealing with cases of this nature.

Medical Reports for Inquests.—If we except medical experts, who are selected according to their experience in different branches of the profession, medical men have no option respecting medico-legal practice, for the cases which give rise to medico-legal questions are always more or less connected with the general practice of medicine and surgery. The initiation of criminal proceedings in England and Ireland is generally in the court of the Coroner. Unless the medical man is supposed to be implicated by maltreatment or otherwise in the death of a person, an order is issued to him to make an inspection of the body and report the results. In reference to cases of poisoning, wounds, and alleged child-murder, the points to which he should especially direct his attention will be found fully described in the chapters on those subjects. It is proper that at the time of the inspection and analysis he should make notes of all that he observes and does; and upon this he may base a report, which should be a summary of the medical facts, and of the conclusions based upon them expressed as much as possible in untechnical language. In another part of the work the reader will find a description of the course to be pursued on such occasions, as well as of the circumstances under which notes are permitted to be referred to by a medical witness; the rules for drawing up medico-legal reports are also fully explained.

There are frequently defects in these reports which it is desirable to point out. The statements are sometimes drawn up in exaggerated language: at

others they are overloaded with technical and therefore unintelligible terms, and the writer is seldom sufficiently careful to keep his facts distinct from his comments. The former may be useful as evidence; the latter are inadmissible.

With respect to the first of these defects, it is very much the practice of medical men, in drawing up reports of medical cases for professional purposes, to use, unthinkingly, exaggerated language. Thus it may be observed in the drawing up of an ordinary post-mortem examination, the lining-membrane of the stomach is described as being 'intensely' inflamed; or some part is 'considerably' injected, or a cavity is 'enormously' distended. Expressions thus loosely employed convey to the legal mind a widely-different meaning from that intended by the reporter. They create also great difficulty in evidence if withdrawn or modified—a change which other circumstances may show to be necessary, and at the same time they place the witness in an undesirable position before the Court. On the other hand, if retained, they may render the facts unsusceptible of explanation upon any theory of natural disease. Such descriptions obviously imply a comparison with similar conditions in numerous other dead bodies; but what is the standard by which they are really measured, and what opportunity has the witness had of creating such a standard in his own mind? In general, it will be found that such expressions have been used without proper consideration, from a habit acquired by the writer in reporting cases for the information of medical men only. Let him who is inclined to use them bear in mind that barristers look much more closely to the strict signification of words than medical men, and that they are always disposed to distrust the judgment of one who cannot speak or write without resorting to the use of the superlative degree.

The free use of *technical terms* in drawing up reports may be attributed to a similar practice in the profession. Putting aside those cases in which a medical man thinks he is displaying his erudition by the selection and use of such terms, there can be no doubt that the greater number of medical practioners fall into this practice from mere habit. They think they are addressing the report to the president and members of a medical society, instead of a coroner and jury who have never in their reading or experience met with such terms, and to whom therefore they are perfectly unintelligible. In a report on the appearances in the body of a man who had suffered from chronic insanity, which was submitted to me for explanation, the following passage occurred:—'The only morbid appearance in the brain was an atheromatous deposit in the Pons Varolii, near the situation of the locus niger.' In another document, the reporter stated, for the information of a coroner's jury, that the 'integuments of the cranium were reflected, and the calvarium was exposed.' If a reporter will use such terms as these or others of a similar kind, such as 'parietes of the abdomen,' 'epigastrium,' 'hypertrophy of the liver,' when it would require no more trouble to put what he means in plain English, he must be prepared to have his meaning perverted or wholly misunderstood. Setting aside the men who act as jurors, it may be observed that educated persons, such as coroners and magistrates, do not commonly include professional terms within the range of their studies. There are but few of them who understand the difference between perineum and peritoneum, or the meaning of the words hemispheres of the brain, pia mater, puncta cruenta, corpora quadrigemina, centrum ovale, &c. They are not likely to know the difference between the cardia and pylorus, nor the nature or situation of the duodenum, jejunum, ileum or cæcum, and are as ready to consider them to be parts of the liver or urinary bladder as of the intestines. On one occasion, I heard a learned judge ask for an explanation of the meaning of the term 'alimentary canal.' A slight consideration will show to any medical practitioner that refined pro-

fessional language is wholly misplaced in a report which is intended to inform and convince the minds of ordinary men upon plain matters of fact.

The last point which calls for comment in reference to medical reports is the loose manner in which facts and comments upon facts, as well as hearsay statements and arguments, are sometimes found blended. If a reporter takes care to eliminate facts from comment, his report is admissible, and may be read at the inquest or trial as evidence. The facts are for the jury—the comments upon the facts, introduced by the reporter, may or may not be just, and are therefore not evidence. Their correctness or relevancy to the case will be elicited in the cross-examination. As a rule, nothing should be entered in a report which is not connected with the subject of inquiry, and which has not actually fallen under the observation of the reporter. The introduction of hearsay statements—i. e. statements made by others, or of circumstances which have come to his knowledge through public rumour—should be carefully avoided.

In the case of *M'Lachlan*, who was tried for the murder of Jessie M'Pherson, at the Glasgow Autumn Circuit, 1862, some discussion arose upon what should and what should not find a place in a medical report. A report was put in at the trial, in which the surgeon of police, who had been authorized to make a post-mortem examination of the body of deceased, stated, in commencing his report, that the body had been found '*under circumstances of great suspicion*,' in a front room, &c. The judge, Lord Deas, here remarked that this was matter which was not suitable to a medical report. So again, in reference to the conclusions drawn, the first and third were as follows:—

1. 'That this woman (the deceased) was *murdered*, and that with extreme ferocity.'

3. '*That a severe struggle had taken place before death.*'

The suggestion of murder was an anticipation of the verdict of the jury. As a general rule, conclusions are limited to the *cause of death*, and no reference is made to ferocity. This passed without comment, but the third conclusion led to the following examination:—

Q. You say that in the kitchen there was evidence of a severe conflict having taken place. What was the nature of that evidence?

A. There were blood-stains upon the end of a box, at the inner side of the kitchen door.

Q. But what led you to say there were marks of a *severe* conflict?

A. These marks were principally upon the flags.

Q. How did that show that there had been a *severe* conflict? The dragging of the body was not a sign of a severe conflict. I therefore want to know what marks of a severe conflict were apparent to you before the dragging commenced?

A. My conclusion that there was a severe conflict was founded upon the streaks that were upon the kitchen floor.

Q. I again ask, what were the marks of a severe conflict before the dragging (of the body) took place?

A. There were regular marks, as if caused by some rough substance.

The Judge (*Lord Deas*) to witness: That is streaking still, and the remark in your report about 'evidence of a severe conflict' just confirms what I have said already as to the introduction of matter not proper to a medical report. (Report of trial, p. 37).

The difficulty here arose from the introduction of comments into the report. There was no evidence of conflict or struggle, as far as this examination went. The facts upon which the witness relied as evidence of a struggle were equally consistent with the dragging of the body after death.

In a medical report of an analysis in a case of suspected poisoning, it is not

necessary that all the details of an analysis should be entered. A general statement of the results, to the effect that certain tests and processes had been used, will be sufficient. In the various analyses connected with the case of J. P. Cook and Ann Palmer (*Reg.* v. *Palmer*), C.C.C., May 1856, an application was made to Dr. Rees and myself to give to the prisoner's attorney, before the trial, a statement of the whole of the details of our analysis of antimony and strychnia. We declined to do this without authority. The Queen's Bench was appealed to, and Lord Campbell decided that there was no legal ground on which such a demand could be enforced. Considering that the medical evidence against the prisoner was so clear and conclusive, the counsel for the Crown advised that we should concede the point, although admitted to be neither in accordance with law nor custom. Upon this advice we acted, but it is not a course which I should recommend any scientific witness to follow in a future case. The result was that, before the trial, these private memoranda were placed in the hands of some professed chemists retained for the defence, whose object was simply hostile criticism. Portions of them appeared in a garbled and fragmentary, and therefore in an incorrect, form in some journals and newspapers, with comments attacking the processes and conclusions before our evidence had been given. It was well known to those who had been guilty of this unprofessional conduct, that under the circumstances, we, as witnesses for the Crown, were precluded from making any reply or giving any explanation. The object, however, in this memorable case, was not truth, but victory. No medical man is called upon to lay himself open to attacks of this nature, or to furnish materials for a cross-examination to 'medical counsel' acting only in the interests of a prisoner. In regard to the chemical research for poisons, chemists generally differ about the process which it may be desirable to pursue in a given case; and although the same result may be reached by various methods, it is by no means difficult to find one who will assert that his is the only correct process, and that all others are fallacious, or to raise by such counter-statements that kind of doubt in the minds of a jury which may lead to the discrediting of a witness's results.

Upon a medical report, and such evidence as may be required to explain it, an accused person may be committed for trial at the Assizes, either by a coroner or magistrate. In the first stage of proceedings under these circumstances, the medical witness goes before the Grand jury, and there, after the administration of an oath, he is required to make a general statement of what he knows of the matter. Such questions are put as may be necessary to elucidate the cause of death; and on the finding of a true bill for murder or manslaughter, the accused is placed upon his trial before one of the learned judges of assize. According to the variable circumstances attending such cases, the medical evidence is called for at an early or late stage of the proceedings. When it is at all doubtful whether the cause of death was owing to any criminal act, it is called for at the commencement of the case, in order to lay a distinct foundation for further inquiry.

It is necessary that a medical witness should remember that copies of his report and depositions, either before a coroner or magistrate, are usually placed in the hands of counsel as well as of the learned judge, and that his evidence, as it is given at the trial, is compared word for word with that which has been already put on record. There is reason to believe that this is not generally known to members of the medical profession, and thus it happens that either from failure of memory, want of accurate observation, or carelessness in giving evidence at coroners' inquests, medical witnesses lay themselves open to severe censure, either by stating matters differently at the trial, or by giving a very different complexion to the facts. Any serious deviations from what is on record will of course tell unfavourably for the witness, supply materials for

a severe cross-examination, and form an excellent ground of defence for the prisoner. The witness's weakness is the prisoner's opportunity, and of course his counsel will not lose the occasion of impressing upon the jury that a man who can on oath give two different accounts of the same transaction is not to believed on either.

Coroners' Inquests.—The proceedings at Coroners' inquests are treated too lightly by medical men. The ignorant and uneducated class of persons who often constitute the jury, as well as the circumstances under which the inquiry usually takes place, are not calculated to inspire great respect for these initiatory proceedings; but still by law and custom coroners' inquisitions are and have been for ages in this country the only tribunals for inquiring into and determining the cause of death in cases of suspected violence; and they are therefore deserving of more attention than is usually shown to them by medical witnesses. The observations elsewhere made in reference to inquests in alleged child-murder apply to all other cases demanding medical evidence. As a rule, in all inquests which are likely to end in a committal of the accused person, a medical man who is giving his evidence before a coroner, in the room of a small country inn, or in a village school-room, is virtually delivering it before a judge of assize; and this fact alone, if not a respect for the Court, should induce him to give the evidence guardedly, and with a due consideration of the serious results to which exaggerations or misstatements may ultimately lead. The deposition should be always read by or to the witness, before he signs it. It is therefore easy for him to correct any error which may have crept into the document by reason of the ignorance or neglect of the coroner's or magistrate's clerk.

Coroners' inquisitions are so intimately associated with the practice of medical jurisprudence in reference to criminal cases, that is impossible to pass over this subject without pointing out what must be regarded as the defects of this method of inquiry. The 4th Edward I., stat. 2, on which coroners profess to act, directs that, 'upon information,' they shall 'go to the place where any be slain or suddenly dead,' and make due inquiry as to the cause, &c., before a jury selected from persons living in the neighbourhood. The information upon which a coroner generally acts is,—1. Notice from a beadle, or other officer of the parish (whose zeal is sometimes stimulated by a fee or salary) of any death from sudden or supposed unusual causes. 2. Notice from a medical man who may have attended the deceased, and who communicates his suspicion that the cause of death is not natural. 3. Notice from a registrar of deaths that no cause has been assigned in a particular case, or that there has been a rapid death after a short illness.

The conclusion to which experience leads in reference to these inquiries is, that the system affords no certainty for the detection of crime; that it affords no protection to those who are wrongly charged with crime; and lastly, that in some cases it screens a criminal by a verdict based upon an imperfect inquiry, in which the important medical facts are either not understood or are misinterpreted by the jury. A remarkable illustration of this statement has been furnished to me by a friend in reference to an inquest held in Suffolk, in September, 1867. A druggist applied to the ulcerated breast of a woman suffering from cancer, *thirty grains* of morphia in powder. The woman was soon afterwards seized with the symptoms of poisoning by morphia in a severe form, and she died in ten hours. The druggist, when examined at the inquest, admitted that he had applied this large quantity of a powerful poison, and in his judgment it was a right and proper application! There was medical evidence that the woman had died from poisoning with morphia by absorption, on which fact there could not indeed be two opinions.

The coroner summed up the case, and the jury returned a verdict of 'death from natural causes.'

Admitting that some crimes (which might have remained concealed) have been brought to light by this system, it is my opinion that, as the inquiry is now conducted, it fails to exercise any deterring influence on criminals. In a large proportion of cases there is no inspection of a dead body. This is probably in order to avoid delay or the expenses of a post-mortem examination. It would be easy to point to cases in which death by poison has been thus concealed, and the fact has only come to light by accident some years afterwards. With rare exceptions, indeed, is it justifiable on the part of a coroner to hold an inquiry on a dead body without a strict external and internal examination of the body. Either the inquiry is necessary, or it is not. If not necessary, the coroner is to blame in holding it; if necessary, an inspection of the body is the very essence of the inquiry, where it refers to one who 'has been slain or is suddenly dead.'

I was once an attendant at a funeral; it was delayed, and the cause of the delay was simply this:—An inquest had been held on the body (a case of very sudden death in a state of health), and a verdict of 'Death from disease of the heart' had been returned. There had been no inspection of the body. When the grave-clothes were removed, and the body was examined, it was found to be covered with bruises, and some of the muscles of the thigh were found reduced to a jelly by blows. Death had been clearly caused by violence. But an inquiry before a coroner for two days had, with all the usual formalities of medical evidence, &c., resulted in a verdict of 'Death from disease of the heart.' Within two hours only of the body being put into the ground, it was clearly proved to be an act of murder or manslaughter. The guilty party was tried, convicted, and punished. (*Reg.* v. *Hopley*, *Lewes Aut. Ass.* 1860.) This case, with several others of a similar kind, establishes two propositions. The coroner's inquest affords no certainty for the detection of crime. It, in some cases, tends to screen a criminal.

The secrets of the grave are only known to those who practise medical jurisprudence. In the course of thirty years' practice, at least fifteen cases of the exhumation of dead bodies were referred to me. On some of these inquests had been held, but no inspections were made. Verdicts of death from cholera or natural causes had been returned, and, at intervals of from one month to twenty-two months, the bodies have been disinterred, and it was then proved that the deceased persons had died from poison. In some of these cases the deaths were sudden, and in others slow; in the latter the symptoms during life were mistaken for those of disease, medical certificates of the cause of death were given without sufficient inquiry: thus it is that crime passes undetected, and several lives may be destroyed in succession before a criminal is arrested in his career. There is a popular notion in accordance with the ancient statute, that *sudden* deaths only require an investigation by the coroner; but this is an error. A large proportion of sudden deaths take place from well-known natural causes, easily elicited by a proper medical inquiry, and they strictly demand no judicial proceedings. On the other hand, in all cases of slow or chronic poisoning, the form which secret murder has of late years assumed, the person has lingered on with intermitting symptoms, and death has taken place only after an illness of some days' or weeks' duration. There is no provision for the detection of such cases. Their discovery appears to be a matter of accident.

As a rule, it may be said that all inquests in which there has been no medical inspection of the body are a vain mockery, and the sooner the public mind is imbued with this proposition the better for society. It is not implied that the bodies of all persons who die suddenly should be inspected. If cir-

cumstances of a suspicious kind justify an inquest, *ipso facto* there should be an inspection. If an inspection is not required, an inquest is not required. Such cases as inquiries into deaths from machinery, railway accidents, &c., where the physical injury is obviously sufficient to account for death without further inspection, are excepted from this remark. The verdicts of coroners' juries are sometimes quite erroneous, and contrary to the medical evidence. Great injury is thus done occasionally to innocent persons. At the Assizes the bill may be thrown out by the Grand jury; but the person inculpated by the verdict may always have a stigma attached to his character, as a result of mistake or misapprehension of medical evidence, or, sometimes, of local prejudice.

Many persons who occupy the office of coroner are neither medically nor judicially qualified for the proper performance of the duties of the office. The system of electing a man to hold such an office as this (one demanding special *medical* knowledge of the causes of death, and good *legal* knowledge of the law of evidence) by freeholders of the lowest degree, is so intrinsically absurd, that is quite wonderful how, with improved knowledge and the advance of civilisation, it has maintained its ground in such a country as England. The election of a Lord Chancellor, of the judges of our Courts of Law, or of County Court judges, might be with equal reason left in the hands of voters of this class—men who have no knowledge of the duties of the office, or of the skill and learning required in one who is really competent to fill it. The election of a good and capable person as coroner is, therefore, a matter of pure accident. No preliminary test of ability or capacity is required.

In Scotland, the officer of coroner does not exist; but in place of this there is an officer named Procurator Fiscal, generally a skilled solicitor, nominated by competent authority, and not elected by scot and lot voters. The general order issued to these officers by the Lord Advocate enjoins that in cases where a dead body is discovered, the Procurator Fiscal shall obtain a medical report of the cause of death; and in cases of persons found dead, the body is generally inspected for this purpose. This, however, is at the option of the appointed officer, the instruction being in these words: 'Wherever in his opinion a written medical report is necessary for the due consideration of the case, he, the Procurator, shall obtain such a report from a duly-qualified medical practitioner.' The usual practice in England is to select the *nearest* medical practitioner, whether he has had any experience or not, and often to trust an important chemical inquiry in the hands of one who probably has never before made an inspection or an analysis for poison.

The steps necessary for the proper identity and preservation of viscera, or other articles for analysis, are neglected. The stomach is cut open, and the contents may be entirely lost. The stomach containing poison is thrown into the same vessel with other viscera, and thus all are impregnated with poison. Evidence of absorption and diffusion of poison through the body during life is thereby entirely destroyed. Stomachs have been sent for analysis wrapped only in brown paper. On one occasion, two stomachs (of children poisoned) were sent in bladders, unlabelled. The identity of these at the subsequent trial for murder could only be made out by the different colour of the string with which one bladder was tied. On another occasion, in a newly-papered room in which a body was examined, the stomach was wrapped in a portion of the paper-hangings lying about: these, as it happened, were coloured with an arsenical pigment, and the poison was thus transferred from the paper to the stomach!

The selection of the nearest medical man, or of any gentleman who will make an inspection and analysis for the parliamentary fee of two guineas, in a case of murder by poison, generally leads to a large expenditure subsequently for a

further analysis before the trial, when the parts in which the poison would be most probably found have been destroyed. On such occasions it is the custom to condemn severely the medical and chemical gentlemen, who have probably, for the first time in their lives, undertaken a case of this serious nature upon the express order of a coroner, with insufficient remuneration for its performance. This is manifest injustice. The fault is in the system, and not in the men, who do their utmost to perform a difficult duty, for the first time, as well as they can.

If a coroner places the inspection of a body in the hands of one who is not well skilled in the appearances produced by poison or disease, it is obvious that a serious mistake may be committed, which may implicate an innocent person. If he places a stomach for analysis in the hand of an inexperienced analyst, it is not the fault of the analyst (whose living depends on his practice) if he undertakes it, and falls into some grievous act of omission or commission. The error is rather with the system; and the sooner it is abolished, and a more reasonable mode of proceeding substituted, the better.

There is for these defects a simple remedy, which is often now resorted to by the coroner in cases demanding great medical and scientific skill—in other words, the evidence of *experts*. After a coroner's inquiry, the whole of the proceedings are sometimes directed to be re-heard before a magistrate or magistrates, who can analyse and sift evidence, and can bring the minds of educated men and trained lawyers to bear upon the facts. A proper analysis and inspection are then made, and the case in this complete form goes before an Assize court for trial. If this is done occasionally in cases of importance, why not in all cases that are now properly the subjects of a coroner's inquiry? Let a well-trained gentleman be appointed as a stipendiary judge in every county or borough; let him, upon the same sources of information as are now open to the Coroner, hold inquiries or not, according to his judgment. There are many coroners who are quite competent to fill such an office. In each county, borough, or district, there should be appointed, as in some States on the Continent, a skilled surgeon—skilled in the inspection of the dead body, and in a knowledge of the causes of death; and a skilled chemist, skilled in the processes for the detection of poisons. To these three officers, and, if necessary, to assistants appointed by and under them, all inquiries into crimes connected with the death of persons should be exclusively remitted. Proper salaries for skilled surgeons and analysts would secure competent men, and probably turn out in the end to be less costly than the present system. The duties of sanitary officers (which are not heavy) might be shared by the medical and chemical gentlemen appointed to these offices.

Some such regulations as these must sooner or later be made if the public desire to have the duties of an important office properly performed. The value of life is said to be greater in England than in any other country; but this remark applies only to cases of crime which are actually detected, and to the prosecution and punishment of criminals. I believe that we are greatly inferior to France and Germany in our means for the scientific detection of crime and murder by secret poisoning. In the case of William Palmer (1856), there was evidence to show that his wife, his wife's mother, two of his children, his brother and one of his personal friends, had all died from poison under his roof, within two or three years before the death of Cook—for the murder of whom Palmer was tried and convicted. His wife had been poisoned by tartar emetic, and his brother by prussic acid. The deaths of at least two others in his house were probably violent. Where was the Coroner's inquest for the protection of life? The initiation of proceedings is usually placed in the hands of a police constable or a coroner's beadle, instead of being directed by a public prosecutor under a Minister of Justice.

Inspections.—The necessity for appointing a skilled independent inspector of bodies in all suspected cases demanding inquiry, will be apparent from other considerations. Under the present system, a person who has destroyed the life of another by poison may be present at the post-mortem inspection of the body of his victim, and may use his efforts to defeat the objects of the inquiry. William Palmer, a medical man, was thus allowed to be present at the inspection of the body of Cook. He nominated the persons, one of them an inexperienced young man who had never before inspected a body in a case of death from poison, and he stood over them while they were engaged in the office. The stomach of the deceased when received for analysis was cut open throughout its length. The injury to this organ, by which at least a portion of the contents was lost, occurred during the inspection, and is said to have arisen from Palmer having accidentally (as it was alleged) pushed against the youth who was making the inspection! After the viscera had been placed in a jar and secured with a bladder, Palmer found an opportunity of cutting the bladder with a knife and inverting the jar, and this probably led to a further loss of the contents. In a case of exhumation in which I was consulted, the viscera had been carefully removed and placed (as it was supposed) in separate jars, which were properly secured and labelled. When the jar labelled 'Stomach and Contents' was opened by the analyst to whom it had been sent, it was found empty. From inquiries subsequently made, there was but little doubt that a person who was interested in preventing an analysis was permitted to be present at the inspection, and that he had taken the opportunity, when the inspectors were otherwise occupied, of removing the stomach from the jar and again secretly returning it into the abdomen before the body was sewn up, or otherwise disposing of it. Acts of this kind should be impossible in the present day, and the best security against their occurrence would be the appointment of a skilled inspector in a district, to conduct all post-mortem examinations for coroners' inquests.

A charge of malapraxis is sometimes raised against a medical man in consequence of the death of a patient. The examination of the body may, by order of a coroner, be unknowingly placed in the hands either of a professional rival, or of a friend of the person inculpated. This is not just either to the practitioner or the public. There is nothing more easy, medically speaking, than to exaggerate appearances in a body, or to assign to the action of medicines, or to the use of surgical instruments, post-mortem conditions to which an independent and experienced anatomical inspector would probably attach no importance. Supposing the question to be that a patient has died from an overdose of opium, said to have been found in the stomach —if the analysis has been intrusted by a coroner to any professional rival, or to an incompetent analyst selected by him, the injury done may be irreparable. These are not imaginary cases: they have occurred and must occur until special inspectors and analysts are appointed in place of men who are now taken by chance, by the fact of their living in the vicinity, or of their being called to see the person while dying.

If a person has had poison administered to him feloniously and he recovers, the facts of the case are duly investigated by a magistrate, the evidence is carefully sifted, analyses are properly made when required, and the depositions are so drawn up as to form a correct basis of proceedings for the trial of the accused. If, however, the person dies from the poison, the case then goes before a coroner and a coroner's jury; and although the medical and other questions which arise are usually of greater importance, they are now dealt with by men frequently incompetent to understand them, and who are not always qualified to elicit the facts or put them into a proper shape for trial. Hence it is that, unless a true bill has been found by a Grand jury at

the Assizes, or the alleged criminal has been committed by a magistrate, no prosecution is commonly instituted. The proceedings taken before a coroner are in this case disregarded by counsel and judges.

There is no doubt that a large number of these officers might be retained with benefit to the public, but the system of nomination by election should be altered. Tried and competent men only should be appointed, and in place of a jury they should have the assistance of persons skilled in a knowledge of the causes of death and in conducting post-mortem examinations and analyses. Under the present system coroners are empowered by the Medical Witnesses' Act (6 and 7 William IV. c. 89) to issue an order for the attendance of any legally-qualified practitioner; a fee of two guineas is the maximum allowed for making a post-mortem examination, and, if considered necessary by the jury, a chemical analysis of the stomach and intestines. A penalty of five pounds is attached to disobedience of this order, except for reasonable cause. Mr. Rumsey has correctly represented the unsatisfactory position in which medical men are placed by such an arrangement. He observes: 'It is no discredit to a practitioner engaged in the toilsome routine of ordinary medical duties, if he should feel himself at a loss when called upon for a decisive opinion in some obscure case of poisoning or infanticide. His scanty opportunities for the study of these subjects and for making post-mortem examinations cannot suffice to qualify him for answering the delicate and important questions which he must answer before a jury can find a proper verdict.' . . . 'The custom of indiscriminately summoning medical practitioners of all sorts, and of all degrees of pathological knowledge and forensic skill, has sadly depreciated the value of medical evidence in courts of justice. Public confidence in the profession has been shaken, and the appearance of a "doctor" in the witness-box is but too often a signal for sport among gentlemen of the long robe.' ('Essays on State Medicine,' p. 356.)

No man can be compelled to undertake that which he feels incompetent to perform, and some medical practitioners who have felt this want of experience have properly declined to make chemical analyses involving so serious a responsibility. It is thus that, in many cases of importance, analyses for coroners' inquests are now referred to chemical experts, and the practitioner discharges himself of that responsibility which the Medical Witnesses' Act imposes upon him without any adequate remuneration.

Before quitting this subject, it is necessary to observe that medical men are too ready to give their opinions of the cause of death for a coroner's inquest without making an inspection of the body. No man is compellable to give an opinion upon insufficient data, and if by the institution of a judicial inquiry there are grounds for believing that a death has not been natural, no medical opinion of the cause should be given in the absence of an inspection. Such an opinion must always be conjectural, and may involve a medical man in an unpleasant responsibility.

Trial at the Assizes.—The next stage of the proceedings in a criminal case brings a medical witness before a superior Court. For this purpose a *subpœna* is issued. It need hardly be observed that every witness is bound to obey a subpœna, when with it his reasonable expenses for journey, &c. are tendered to him, but he is not bound to attend at the trial except upon a subpœna. There are some questions connected with this subject which it will be proper to consider in this place. *If a subpœna is served on an ordinary or skilled medical witness, is he bound to obey it?* In *Betts* v. *Clifford* (Warwick Lent Assizes, 1858) the late Lord Campbell stated, in answer to a question, that a *scientific witness* was not bound to attend upon being served with a subpœna, and that he ought not to be subpœnaed. If the

witness knew any question of *fact* he might be compelled to attend, but he could not be compelled to give his attendance to speak to matters of *opinion.*

In *Rich* v. *Pierpoint*, an action for malapraxis, Dr. R. Lee was summoned against his will to give evidence on the part of the plaintiff. He stated that on the evening before the trial a solicitor called on him and left a subpœna with him. Dr. Lee would not hear any account of the case which the solicitor proposed to give, and expressed his resolution to have nothing to do with the trial. The solicitor informed him that he would be required to pay the usual penalty if he did not attend. He went down to Kingston, and was warned not to leave the Court until the trial was over. He heard the evidence on the part of the plaintiff, and upon this and the medical evidence he gave his opinion—not much in favour of the party who summoned him, and not much against him. Dr. Lee considered that he could not avoid attending the trial under these circumstances. ('Medical Times and Gazette,' April 12, 1862, p. 389.)

In the case of *Webb* v. *Page* ('Carrington and Kirwan's Reports,' p. 23) the late Mr. Justice Maule ruled as follows:—'There is a distinction,' said his Lordship,' between the case of a man who sees a fact and is called to prove it in a Court of Law, and that of a man who is selected by a party to give his opinion on a matter on which he is peculiarly conversant from the nature of his employment in life. The former is bound, as a matter of public duty, to speak to *a fact* which happens to have fallen within his own knowledge—without such testimony the course of justice must be stopped. *The latter is under no such obligation*; there is no such necessity for his evidence, and the party who selects him must pay him.' In the case referred to by Mr. Justice Maule, a skilled witness had been subpœnaed, but refused to give evidence unless first paid for his services and loss of time ('Medical Times and Gazette,' April 26, 1862, p. 432). A barrister, who quotes this ruling, goes on to say: 'There is one reason why I should not advise any person in the position of a skilled witness totally to disregard a subpœna. It is quite clear that should such a person fail to attend a trial no attachment could issue, even if he were called as is usual upon the subpœna, because the party subpœnaing him could not make the requisite affidavits that he was damnified by the witness's absence and in what respect. But such party might bring an action for damages; and although he would recover none, he might not only worry, but might even put the defendant to a considerable expense, as taxed costs by no means include the entire costs in such cases. Although, therefore, I could not advise a total neglect of the subpœna, the safest course would be to obey it, and demand expenses before giving evidence. Such expenses would be only those allowed for a professional witness (not special fees); but if the person so subpœnaed were willing to run the risk of an action, he might safely absent himself without any fear of an attachment from the Court for contempt.' With regard to the question whether a skilled witness would be permitted to demand a high fee for his attendance under such circumstances, the writer adds: 'To permit him legally to demand a high fee would perhaps look somewhat like legally countenancing a bribe.' At all events there is no such legal recognition.

In a case which came before the Court of Exchequer in May 1868 (*Maxsted* v. *Morris*), a witness wilfully disobeyed a subpœna. In consequence of this the trial was postponed, and the parties were put to great expense. An arrangement was made by which the witness bound himself to pay a part of the expenses. The Chief Baron said: It must be distinctly understood that in all cases where it appeared to the Court that there had been a wilful disobedience of a subpœna after proper service, such a contempt of Court would be visited with the punishment it deserved. Martin, B.: It was not to

be tolerated that a man should exercise any discretion as to whether he would or would not attend a Court in pursuance of a subpœna. Enormous costs were incurred in preparing a case and bringing it down to trial, the whole of which were to be thrown away and wasted, because a man refused to obey a lawful summons to attend as a witness. Pigott, B.: A subpœna was not to be treated as mere waste paper. Public justice required that persons wilfully committing contempt of Court should be dealt with in such a manner as to teach them that they could not commit a contempt of Court with impunity.

The question may not be one of fees, but of obedience to a simple order to attend and give evidence on matters of *opinion* irrespective of scientific facts. In a case before Vice-Chancellor Wood (*Simpson* v. *Halliday*, 1864), I was required to attend on a subpœna as a skilled witness, to give evidence of *opinion* in reference to the alleged infringement of a patent. The defendant, who summoned me, did not make it in any way a question of fees; but being wholly unacquainted with the facts of the case, I did not feel in a position at a short notice to appear as a witness for parties of whom I knew nothing. I obeyed the subpœna, as the disobedience of it might have been, in the present uncertain state of the law, a contempt of Court; and after giving my evidence, I requested his Honour to state for future guidance whether a skilled witness was compelled to attend under such circumstances as those in which I had attended. I referred him at the same time to the decision of Lord Campbell in *Betts* v. *Clifford*. The Vice-Chancellor said that a Court of Law never gave an opinion on a speculative question, and there the matter ended.

It would seem therefore that a skilled witness, who is not acquainted with *any of the facts* of a case, may be compelled by a subpœna to attend and give evidence on a matter involving scientific opinion alone. Some months before this occurrence, I had given evidence in a similar case, and the defendant Halliday, seeing that my opinion in that case was favourable to his views, exercised a right to impound my services on his behalf. When some portions of the public press undertake to censure experts for acting as hired witnesses, it may be as well to remember that they may be sometimes unwillingly forced into Court by subpœnas which they dare not disobey.

Lord Campbell's dictum in reference to the distinction between fact and opinion confers no practical benefit on witnesses. It is at all times difficult in science, and in the medical sciences particularly, to separate them; and if a man appears to testify to a medical or scientific fact, he cannot avoid giving an opinion arising out of the fact. In a recent action against a druggist for a mistake in compounding medicine, an attempt was made to procure my *opinion* as a skilled witness at the trial, by reason of *facts* obtained from the report of a chemical analysis, the object of which was at the time entirely concealed from me. The suit was fortunately compromised, and my attendance was not necessary; but such a case should convey a caution to chemical experts. They may be employed secretly and under untrue statements to make analyses; these become *facts* on which they may be summoned like ordinary witnesses to give *opinions* as skilled witnesses, while the payment of the usual fee for a skilled witness is evaded.

A medical man may be placed in the disagreeable position of receiving separate subpœnas, to attend trials at different Assizes which are held at or about the same time. An obedience to both of them is clearly impossible—one at least must be sacrificed to the other. I have been placed in this position on three occasions, and on one of these I was called from a civil trial which had commenced in the Assize Court at Durham, to a criminal trial which was fixed to take place on the same day at Lincoln. The civil case was postponed, and I had so far the benefit of the opinion of one of the most learned judges on the Bench, that in all cases in which there were served separate subpœnas

fixing trials for the same time, the civil should give way to the criminal case. The former can be postponed, the latter cannot. But if the subpœnas are for two criminal cases, the course of a witness should be to attend to that in which the subpœna was first served upon him.

CHAPTER 2.

COMPULSORY ATTENDANCE IN COURT—LICENSE OF COUNSEL—EXAMINATION IN CHIEF—CROSS-EXAMINATION AND RE-EXAMINATION—QUOTATIONS FROM BOOKS—PRESENCE OF MEDICAL WITNESSES IN COURT—RULES FOR THE DELIVERY OF MEDICAL EVIDENCE—TECHNICAL TERMS—MEDICAL EXPERTS—MEDICAL COUNSEL—CONFLICTING MEDICAL TESTIMONY.

Assuming that the medical man has obeyed the subpœna, he will now be required to attend before the Court, and to state, in the face of adverse counsel, the opinions which he has formed from the medical facts of the case, as well as the grounds for these opinions. He will then for the first time undergo the ordeal of a public examination.

Before being sworn to deliver his evidence, a medical or scientific witness may claim the payment of his customary fees, unless an arrangement has already been made between him and the solicitors who have sent him a subpœna. These fees are generally made a matter of private arrangement between the witness and the attorney. Unless there is such an arrangement, or some written document to show an agreement as to the amount, the witness will be paid according to a tariff which will not even suffice to indemnify him for the expenses necessarily incurred by a journey to or residence in an assize town; not to mention the loss occasioned in his practice during this forced absence from it. This is necessarily a source of great dissatisfaction among members of the medical profession. The country impounds their services for the administration of justice without making a proper remuneration to them. In some exceptional cases a special application made to the Court may have the effect of rectifying this matter.

An attorney who serves a subpœna is not liable for the fees. In a case in which an action was brought against an attorney for the amount of the fees, Bramwell, B., said: 'As a rule an attorney was merely the agent of another person, and if he simply subpœnaed a man, he was not liable, the witness's action for expenses being against the principal.' This shows the necessity for a special agreement.

Some medico-legal writers have considered it necessary to lay down rules respecting the manner in which a medical witness should give his evidence; how he is to act on a cross-examination, and in what way he is to recover himself on re-examination. Any advice upon this head appears to me to be quite superfluous; since experience shows that these rules, like those given to prevent drowning, are invariably forgotten at the very moment when the individual is in the situation in which he most requires them. A man who goes to testify to the truth to the best of his ability should bear in mind two points. 1. That he should be well prepared on all parts of the subject on which he is about to give evidence. Let him remember on these occasions the advice contained in the Latin motto, *ne tentes aut perfice*. 2. That his demeanour should be that of an educated man, and suited to the serious occasion on which he appears, even although he may feel himself provoked or irritated by the course of examination adopted. A medical witness must not show a testy disposition in having his professional qualifications, his experi-

ence, his means of knowledge, or the grounds for his opinions very closely investigated: he should rather prepare himself to meet with good humour the attempts of an adverse counsel to involve him in contradiction, and show by his answers that he has only a desire to state the truth. Law and custom have long established that a barrister, in defending a prisoner charged with murder, has a right to make use of all fair and even what may appear at the time to the witness unfair means for the defence. Nothing can tend more to lower a witness in the opinion of the Court and jury, or diminish the value of his evidence, than the manifestation of a disposition to deal with his examiner as if he were a personal enemy, to evade the questions put, or to answer them with flippancy or anger. All such exhibitions invariably end in the discomfiture of the witness. It has been suggested that medical men on these occasions might take a lesson from lawyers, and observe how little they allow forensic differences, which they put on with their professional costume, to influence them in their intercourse with each other, or with an adverse judge or jury.

License of Counsel.—Medical men have complained, and on many occasions justly, of the license of counsel. On this subject it may be well to consider what has been said by one of the highest authorities on the Bench, Chief Justice Erle:—'The law trusts the advocate with a privilege in respect to the liberty of speech which is in practice bounded only by his own sense of duty; and he may have to speak upon subjects concerning the deepest interests of social life, and the innermost feelings of the soul. The law also trusts him with a power of insisting upon answers to the most painful questioning, and this power again is in practice only controlled by his own view of the interests of truth.' (Judgment in *Kennedy* v. *Broun*, 1862.) Thus it will be seen that almost unlimited powers of interrogation are entrusted to counsel by the law, and it is a serious question whether the unrestricted use (which it has been justly remarked means only the frequent abuse) of these enormous powers is necessary or even favourable to the administration of justice.

One of the most severe reprimands on this abuse came from the same learned judge in a case which was before him in 1857; it was addressed to a learned serjeant now deceased, and was to this effect:—A question had been put throwing on the witness an imputation for which there was really no foundation. The learned judge then said: 'The freedom of question allowed to the bar was a public nuisance, and the barrister who made such an imputation ought to be prosecuted. If a question had relation to the truth, he was most anxious it should be put; but to cast haphazard imputations at the suggestion of a person (an attorney) who might have no scruples as to what he did, was a degree of mischief that made him wish that a party should be prosecuted. He begged leave to say that in his experience he had seen counsel so abuse their privilege, that he had cordially wished a power could be instituted that they might be prosecuted for a misdemeanour.' It is the general practice to say that the obnoxious questions are in the instructions, but a barrister can always exercise a power of putting or not putting a question which may be found there. Mellor, J., observed on one occasion that 'he did not approve of counsel throwing everything upon the attorney. The counsel who put an improper question ought not to be shielded merely because he had been instructed by an attorney. Counsel should always exercise caution in putting a question.' By putting it he clearly adopts it, and frequently to the great damage of his own case. This is at present the only check upon the practice, for learned judges seldom interfere unless directly appealed to by the witness.

Some medical men have claimed a privilege not to answer certain questions which are put to them, on the ground that the matters have come to their

knowledge through private and confidential communications with their patients. It is right to state at once that the law concedes no special privilege of this nature to members of the medical profession. No man is bound to reply to any question if the answer would tend in any way to incriminate himself—for no man is compellable to be a witness against himself. With this exception all questions must be answered, provided they are relevant to the case, and their relevancy is a matter for the consideration of the learned judge who presides. Sometimes a witness makes a frivolous objection—the refusal to answer an ordinary question—bringing only ridicule upon himself. A skilled expert, at an important trial, was asked his age. Instead of answering so simple a question at once, he angrily appealed to the judge to know whether he was bound to give an answer on a matter which, as he said, could have nothing to do with the case. The judge informed him that unless he had some very strong reasons for concealing it, he had better state it. I was once present at a trial for murder by poison, when in the course of a cross-examination counsel for the prisoner asked the medical witness what remedy or antidote he had employed when he was first called to attend the deceased. He appealed to the judge to know whether he was bound to answer such a question as that. *Judge:* 'Yes, unless you have reason to believe that your antidote killed the deceased. In that case you are not bound to answer it!' The question was immediately answered.

As there is no special privilege granted to members of the profession, a witness must remember that there are *no medical secrets.* In the case of the *Duchess of Kingston* this privilege of withholding statements was claimed by a medical witness but denied. In a case in which a female was indicted for the murder of her infant, a surgeon was called to prove certain confessions made to him by the woman during his attendance. He objected, on the ground that he was then attending her as a private patient. The learned judge (Park, J.) said this was not a sufficient reason to prevent a disclosure for the purposes of justice, and he was ordered to answer the questions. (Beck's 'Med. Jurisprudence,' vol. ii. p. 922.) At the meeting of the British Medical Association at Leeds (August 1869), Mr. Bateman said, 'There are many cases in which a doctor cannot discharge his duty to a sick person without putting questions the replies to which may criminate the patient, or seriously affect his interests, and these replies the doctor is now called upon to communicate, either in a civil or a criminal Court.' A case was mentioned in which two sisters were servants to an old lady. One of them became pregnant, miscarried, and was attended by a surgeon. The mistress, who knew all about the matter, retained the girl in her service, and left her a legacy at her death. The will was disputed by the heir-at-law on the ground of undue influence, and at the trial, in order to injure the girl's character, the surgeon was called, and asked for what illness he had attended her some years before. Believing that he had a privilege, he refused to answer, but it was decided by Vice-Chancellor Kindersley that he had no privilege, but was bound to tell all he knew, and this decision put him to an expense of 30*l.* for costs. In cases of a criminal kind the same point has several times arisen; and it has even happened that the reply made by the accused to a doctor's professional question has been the sole evidence on which a conviction could be based. It will be perceived, therefore, that any statements which are made to physicians or surgeons while attending persons in a private capacity, although they are not to be volunteered in evidence, must be given in answer to questions whatever consequences may ensue. Cases of poisoning and wounding, duelling, as well as cases which involve questions of divorce, or the legitimacy of offspring, may be materially affected by the answers of a medical man on matters which have been the subject of

private communications. The difference between the English and the French practice will be seen by reference to a paper by M. Hemar, 'Ann. d'Hyg.,' 1869, vol. i. p. 187.

Examination-in-chief.—The ordinary course of proceeding in a criminal case is thus concisely stated by Mr. Fitzjames Stephen ('Criminal Law of England,' pp. 168, 282). After opening the case the counsel for the Crown calls the witnesses, and examines them according to the rules of evidence—that is, he brings out by questions *which do not suggest their answers*, the facts relevant to the issue to be tried which are within his personal knowledge. Those questions which suggest the answers are called 'leading' questions. With one exception it is not the practice to allow these to be put in this part of the examination. The exception according to Mr. Stephen is: 'When the judge is satisfied, either by a witness's demeanour or by contradictions between the evidence and the depositions, that he is trying to keep back the truth and favour the prisoner, he may in his discretion allow the counsel for the Crown to ask leading questions and, as the phrase is, to treat the witness as hostile.' When the examination-in-chief has been given, the next step is the cross-examination.

Cross-examination.—In this, the second stage, the counsel for the prisoner extracts from the medical witness, by questions *which may suggest the answer in the strongest form*, any facts that may appear to be favourable to his client, and which he believes to be within the witness's knowledge. Leading questions are not only allowable in this part of the examination, but, according to good authority, a counsel for the defence can hardly lead too much. The theory of the law is that the witness is unfavourable to the prisoner and has come to bear evidence against him. The more he has shown himself by conduct or conversation a partisan in the case, the more severely will he be treated. Anything which he may have said in the hearing of others, or published in journals or even written in private letters (if the contents transpire) in reference to the case or the guilt of the prisoner, is now brought to light, although he may have supposed that what he did say was in perfect confidence. It is at this stage of the case that any exaggerations which may have been most favourably received by the counsel for the prosecution are reduced to their true proportions. Any bias by which the mind of a witness may have been influenced, or any imperfection or confusion of memory as to facts, is here brought out. (Stephen, p. 177.) It is in this part of his examination that the witness will be closely questioned as to his qualifications, the time during which he has been engaged in practice, the accuracy of his judgment, his general professional knowledge, and his special experience in reference to the matter in issue, the number of cases he has seen, &c. Straightforward answers should be given to all these questions. No harm can be done to the witness by the answers unless they are given evasively, since it is not to be supposed that the witness wishes to represent himself differently from what he is. If he does make the attempt, he will assuredly fail. The most striking distinction between the examination-in-chief and cross-examination is in reference to leading questions. It rests upon the assumption that there is a danger that a witness will say whatever is suggested to him by the one side, and conceal everything that is not extorted from him on the other. It need scarcely be observed that witnesses whose evidence is of little importance in the case are rarely cross-examined. This, however, is reserved in its most stringent form for those whose knowledge of facts and whose opinions are likely to influence the fate of a prisoner in a criminal trial.

In dealing with a skilled witness whose evidence may be of importance, the

questions in cross-examination are usually put by the counsel for the prisoner with great caution, or the answers brought out may be more adverse to his own case than those elicited in the examination-in-chief.

Re-examination.—The cross-examination is usually followed by a re-examination on the part of the counsel for the Crown, or of the counsel by whom the witness has been called. The object of this is to clear up or explain any portion of the evidence which may have been rendered obscure or doubtful by the cross-examination. It is sometimes unnecessary to put a question, and if the witness has given his evidence consistently and fairly no questions may be asked. As a rule the re-examination must be confined to those matters which have arisen out of the cross-examination. Any questions upon new subjects may render a further cross-examination on them necessary. In reference to *facts*, a medical witness must bear in mind that he should not allow his testimony to be influenced by the consequences which may follow from his statement of them, or their probable effect on any case which is under trial. In reference to *opinions*, their possible influence on the fate of a prisoner should inspire caution in forming them; but when once formed they should be honestly and candidly stated without reference to consequences. It will be well to remember, in regard to each stage of the examination, what a great medical authority has said:—'To make a show and appear learned and ingenious in natural knowledge may flatter vanity. To know facts, to separate them from supposition, to arrange and connect them, to make them plain to ordinary capacities, and above all to point out their useful applications, should be the chief object of ambition.' (William Hunter.)

Quotations from Books.—It is a not unfrequent custom with counsel to refer to medical works during the examination of a witness. He is expected to have a fair knowledge of the writings of professional men in reference to the subject of inquiry. The authority is mentioned, the passage is quoted, and the witness may be then asked whether he agrees with the views of the author or whether he differs, and if so, his reasons. In cases connected with medical treatment, the views of the profession are and have been so various, that a barrister would have no great difficulty in finding some book to oppose to the opinions of a witness. Standard works of recent date are so well known to the profession that there are few medical men engaged in practice who are not acquainted with and able to explain the views of the writers and how far they agree or conflict with his own. The witness must be on his guard that the quotation is fairly made, and that it is properly taken with the context, or he may unexpectedly find himself involved in a difficulty. On one occasion I found that a learned gentleman stopped in his quotation at a comma, and on another occasion a quotation ended at a colon—the remainder of the sentence in each case materially weakening the inference which it was intended to draw with the apparent sanction of the witness!

When a quotation from a standard work is thus opposed to the evidence of a medical witness, he should take care by reference to the work itself to see that the passage is correctly quoted. A remarkable instance of the importance of this caution has been communicated to me by a former pupil. At the Swansea Lent Assizes 1869, an action was brought against a Railway company for compensation for personal injury. Plaintiff was proved to have had pneumonia shortly after the accident, and the counsel for the company wished to show that the pneumonia had not arisen from any physical injury. In cross-examining the medical witness he asked, 'Cannot pneumonia be produced by shock?' *Witness:* 'I do not believe it to be possible.' *Counsel:* 'What! do you mean to say you do not believe what is asserted in fact by

no less an authority than Professor Taylor? Have you read Dr. Taylor's work on "Medical Jurisprudence?"' *Witness*: 'Yes.' *Counsel*: 'Have you seen the last edition?' *Witness*: 'No.' *Counsel*: 'I have it here (turning over the leaves of a book), and a case is given of pneumonia being caused by shock.' (Witness in confusion.) It was subsequently discovered, on referring to the work, that the case in question was one in which the lung had been wounded by a fractured rib. The cause of the pneumonia was thus sufficiently explained; it was proved to have been a result of physical injury and not of shock! A reference at the time to the work which is quoted is always necessary if any use is to be made of a quotation. Without suggesting that there is intentional misrepresentation to bear out a particular view of the case, a barrister, in dealing with the medical facts, may wholly misunderstand the author's views and statements, and in some instances wrongly assign to the author himself, opinions which he has merely quoted from other authorities for comment or illustration.

Presence in Court.—In England medical and scientific witnesses, except under special circumstances, are allowed to be present in Court and hear the whole of the evidence in the case. This is in some instances absolutely necessary if the Court requires medical opinions, for unless the witnesses are fully acquainted with the facts they can give no opinions, and they can only become fully acquainted with the facts by being allowed to be present and hearing the evidence in Court. If excluded, the judge or counsel will be compelled to read to the witness notes of the evidence before an opinion can be given, and it may then appear that some small point which counsel did not think of importance is omitted: this if known to the witness might, however, materially affect his opinion. A failure of justice is likely to occur when medical witnesses are excluded, and it is generally where there is no defence or a false defence that the right of excluding them is exercised. The rule in Scotland is different; medical witnesses are there rigorously excluded from Court until after they have delivered their evidence.

The examination of the witnesses for the Crown is followed by the defence of the prisoner, either in person or by his counsel, who acts throughout the part of an advocate, simply securing for his client every advantage the facts or the law may afford him. In other words, he sees that his client is strictly tried according to law, and not condemned contrary to law.

A key to some of the difficulties which medical witnesses must be prepared to encounter will be found in the exposition given by Mr. Stephen of the tacit rules which regulate the duties of counsel for the prosecution and defence:—'In practice it is universally admitted that the counsel for the prosecution is morally and professionally bound always to keep in sight the ultimate object—namely, the discovery of truth; whereas no such obligation is laid upon the prisoner and those who represent him, because it is too much to expect of human nature that they should discharge it, and it is better not to impose an obligation which is sure to be systematically violated. Both sides, on the other hand, are bound in the strongest way *not to do anything to propagate falsehood.* The counsel for the Crown is bound not to suppress any fact within his knowledge favourable to the prisoner; and, on the other hand, the counsel for the prisoner is bound not to bring to light facts within his knowledge unfavourable to the prisoner. 'The counsel for the Crown may not use arguments to prove the guilt of the prisoner which he does not himself believe to be just, and he is bound to warn the jury of objections which may diminish the weight of his arguments: in short, as far as regards the evidence which he brings forward, his speech should as much as possible resemble the summing-up of the judge. He should contend not for the success

of his cause at all events, but for the full recognition by the judge and jury of that side of the truth which makes in favour of it. On the other hand, the counsel for the prisoner may use arguments which he *does not believe to be just*. It is the business of the jury, after hearing the judge, to say whether they are or are not just.' (Op. cit. pp. 160 and 168.) The last remark shows what appears to be a serious defect in the administration of the criminal law. While in a case of misdemeanour a prisoner may be tried by a special jury, in a case of felony, involving an analysis of important questions of medical science in reference to murder or manslaughter, the trial takes place before a common and comparatively ignorant jury. Such a jury is hardly in a position to cope with an ingenious counsel, who has it in his power to misrepresent and distort medical facts and opinions in any manner that he pleases. The chapters on Infanticide will furnish numerous illustrations of the measure which counsel take of the intellectual capacity of common juries. The defences made are frequently such as no counsel would venture to place before a jury of educated men. These 'sensational or powerful' addresses, as they are termed by the press, full of burning eloquence and impassioned logic, have frequently withdrawn the attention of the jury from the real facts, and have procured verdicts of acquittal contrary to the evidence and all the medical circumstances of the case.

Another observation made by Mr. Stephen more nearly concerns the medical witness:—'There are many obligations which affect each side equally. Neither is at liberty to attempt to browbeat, intimidate, or confuse a witness, although they may expose any real confusion which exists in his mind, or test, by the strictest cross-examination, the accuracy of his statements. Neither is at liberty willfully to misunderstand a witness, or to *misstate, in his address to the jury*, the effect of what he has said, either by distortion or suppression. The neglect or observation of these and other rules of the same kind practically establishes a wide distinction, and one which is easily recognised, between those who exercise a noble profession and those who disgrace it.' (Op. cit. p. 168.)

The treatment of a medical witness, in passing through the ordeal of an examination at a criminal trial, will depend therefore very much upon the class of counsel who may be opposed to him. Assuming that the witness is properly prepared for the discharge of his duties, and that the questions put to him are answered fairly and truly, according to his knowledge and experience, without exaggeration or concealment, he has no reason to fear any attempt at intimidation. Barristers, for the most part, know that by this line of conduct they lose more, even with a common jury, than they gain by the attempt to confuse the witness; and as their ultimate and sole object is a favourable verdict, they will generally avoid conduct which must necessarily place this verdict in jeopardy.

The normal barrister, as depicted by Mr. Fitzjames Stephen, is not at liberty, in his address to the jury, to misrepresent, either by distortion or suppression, the medical facts or opinions given in a case. According to my experience, however, misrepresentation is a not unfrequent practice, and one of which medical witnesses have very strong reason to complain. Whether such misstatements are in some cases wilful or not it may be difficult to determine, but their effect on the jury is well known to those who employ them, and they frequently escape the observation of counsel on the other side, and even of the learned judge, unless he happens to be well versed in medical subjects. It is also worthy of remark, that if a misstatement is thus made, it is by a remarkable coincidence always in favour of the view of the counsel who makes it, when a proper examination of his notes would, in general, show him that he was wrong.

Then as to the question of intimidation, this is sometimes carried too far. On a trial for murder by poisoning, I have heard a respectable country practioner, who had given his evidence for the Crown in a fair and proper manner, thus addressed in cross-examination by a learned counsel now deceased:—'On your solemn oath, Sir, and in the face of the whole profession, will you venture to persist in that statement?' Again, the intimidating modes of address—'Do you mean to swear?' 'Will you pledge your professional character?' &c., intermingled with the admonitions, 'Pray be careful,' 'Be cautious,' &c.—of course suggest to the witness that his examiner already regards him as perjured, and that however truly he may state the facts within his knowledge, he will not be believed.

A public writer, in commenting on this subject, says, 'But the hardest and most unfair part of the system (of cross-examination) is when witnesses have to bear a loud and insulting tone or gesture without remonstrance or retaliation. A counsel may very plainly imply that a respectable witness is a person of doubtful character, and not to be believed on his oath, or that he is ignorant, and a bungler in his profession; but if the witness retorts that the barrister's eloquence and sympathies are hired, or if he gives vent to any other words of retaliation in his natural indignation, the Court is against him.' At the trial of Kelly for the murder of Police Constable Talbot (*Reg.* v. *Kelly*, Dublin Commission Court, November 1871), Mr. Tuffnell, a surgeon of repute, and formerly Professor of Surgery, was summoned as a witness for the prosecution. Having deposed to the nature of the wounds, and that the deceased had died from the effects, he was subjected to the usual ordeal of a cross-examination, but in a somewhat unusual form. Counsel for prisoner having begun by addressing him in a loud and offensive tone, he turned to the Chief Baron, and said, 'My Lord, I am very excitable, and if this gentleman has a right to roar at me, I consider that I have a right to roar too.' The Court expressed a hope that it would not be necessary for him to roar, and intimated, after a short trial of vocal strength between the two opponents, that counsel's manner to the witness was not what it ought to be. Counsel disclaimed any intention of being offensive, but claimed the liberty which is usually conceded in cases of importance. Whatever may be the importance of a case to a prisoner, nothing can justify the putting of questions in a loud and insulting tone to a skilled professional witness. The very mild rebuke administered to counsel on this occasion was not likely to produce much effect, and accordingly this trial presents in a concentrated form all the defects of our method of getting at truth by cross-examination. The result is seen in the unsatisfactory nature of the verdict, which was against the medical and general evidence in the case.

I quite agree with a writer whose opinion I have already quoted, that 'Every contemptuous and even uncourteous expression, every query leading nowhere, except to the end of confusing the mind or irritating the temper of a witness, ought surely to be reckoned as overpassing the legitimate limits of the counsel's office, and as such be regarded with universal disapprobation.' That the administration of justice should be aided by this mode of dealing with medical witnesses is impossible; for the object of the examining counsel is not to arrive at facts, but to bring about a result which he has predetermined to obtain, whether the facts justify it or not. It may be that criminal cases fall more into the hands of the second class of barristers to whom Mr. Stephen alludes—namely, those who disgrace a noble profession. But it is a widely-spread opinion in the medical profession, that this style of examining educated men, who are perhaps compelled most unwillingly to appear on a subpœna to testify to facts, is certainly not adapted to elicit the truth, but rather to favour the escape of criminals and give impunity to crime.

It may be fairly admitted that a man who puts himself forward as a witness, and attempts to elucidate what he only succeeds in rendering more obscure, should receive no favour at the hands of the bar. Dr. Elwell, a member of the legal as well as of the medical profession, observes that—'No witness is ever compelled to appear and testify to what *he does not know*. He may be compelled to attend in Court in obedience to a subpœna; but if he attempts to testify upon a subject requiring *opinions* upon which he has no well-settled or well-defined ideas, it is his own fault, and he alone is to blame; for no one but himself can know so well as he, until he has exposed himself, how unfit he is for the occasion.' (Medico-legal Treatise on 'Malpractice and Medical Evidence, by J. J. Elwell, M.D., Member of the Cleveland Bar, New York, 1863, p. 302.) But let us take the case of a practitioner who, in a country district, has gone through twenty years of practice with honour and credit in his neighbourhood, and who is suddenly called to a case in which a man is found dead from a wound in his throat. Under the Medical Witnesses' Act he is compelled to make an examination of the body for a Coroner's inquest. At a great loss of time, and for no adequate remuneration, he attends the inquest and gives his evidence; he is bound over, *nolens volens*, to appear for the first time as a witness at a criminal trial, and to testify, 1st, to the throat being cut, and 2ndly, to give his opinion to the Court on the cause of death, and whether the wound was inflicted by the deceased on himself, or by another person. A medical man who limited himself to the statement of the bare fact that the deceased's throat was cut need not appear at all, for this evidence might be supplied by a constable or policeman; but the law presumes from his profession, that the medical man made a proper examination of the wound, with a view to determine, to the best of his ability, whether it was the cause of death, and whether it was or was not self-inflicted. It is difficult to understand how a medical man, although before this occurrence he may never have seen a case of cut-throat, could excuse himself from giving answers to these questions, both of which involve purely matters of *opinion*. If he excused himself altogether from giving answers, there would be a failure of justice, and no conviction for such a common form of murder could ever take place. If, on the other hand, he answers these questions to the best of his ability, he may reasonably complain that while thus compelled to appear as a witness to testify to what he knows, his evidence should, by rules of law, be made the subject of abuse and ridicule before his neighbours, when he expresses his *opinion* from the facts; and that the counsel who examines him legally possesses an unlimited power of misrepresenting his views. A medical man is certainly not benefited in public opinion by being described as an ignoramus or a blunderer in his profession, whom no one ought to trust. The truth is, in medical evidence facts and opinions cannot be separated; and if medical practitioners were restricted in their evidence only to those facts which they observed in a case in which no other professional man saw the person living or dead, it is difficult to understand how crime could be detected and punished. These remarks of course do not apply to cases in which the opinions of medical experts can be taken. Here it would be desirable that one who has not had experience on the subject should avoid giving any opinion; he might simply state the facts, and decline for want of experience to give an opinion on the conclusions to which they lead. In pursuing any other course, he will find that the whole weight of the cross-examination will fall upon him.

There are other remarks on this subject made by Dr. Elwell, which those who are compelled to attend as witnesses in a Court of Law will do well to bear in mind:—'However anxious an incompetent witness may be to appear learned, and however hard he may labour to show it, he will ever find it a

difficult business to make the Court and counsel believe that he is really so. To appear really learned, he must be able to make the subject on which he gives an opinion *clear*, and to give *satisfactory reasons* for this opinion. He must be not only a thinker, but must satisfy others that he is master of the subject. Take almost any one of the important scientific questions upon which a professional witness is called to pass an opinion, and unless he has *looked at the subject before with a purpose to understand it*—comprehending its extent, weight, and relations—he will find it to have suddenly assumed an importance he had not suspected, just at the time when the discovery will add to his confusion. It is better to make this discovery in the quiet stillness and security of solitude, than under the eye of a judge and the severe scrutiny of counsel. A man, whether learned or not—whether in Court or out of Court—will talk clearly upon a subject he well understands, whether it is scientific or otherwise; but *unless it is clear in his own mind his account of it will be confused and unsatisfactory.*' (Op. cit. p. 303.) This is undoubtedly the test to which every man should rigorously submit himself before entering the witness-box. The case should be viewed in all possible aspects, and if an opinion has been formed, it should be dealt with and criticised as if it were that of an adversary. As in controversy, a disputant should put himself as much as possible into the position of his antagonist, and see the question from his point of view. In this kind of self-examination it may be well to remember two points—1st, that there is no opinion so certain as that the human mind, if left to itself, will not infallibly raise a difference of opinion upon it; and 2ndly, that a man is never so near an error as when he claims a complete immunity from error.

Rules for the delivery of Evidence.—There are a few rules bearing upon medical evidence which if observed, may save the witness from interruption or reproof and place him in a favourable position with the Court:—

1. The questions put on either side should receive *direct* answers, and the manner of the witness should not be perceptibly different whether he is replying to a question put by the counsel for the prosecution or for the defence.

For reasons elsewhere assigned (p. 22), most of the questions put by counsel in cross-examination will admit of an answer 'yes' or 'no.' If, from the ingenious or casuistical mode in which the question is framed, the witness should feel that the simple affirmative or negative might mislead the Court, then, after giving the answer, he can appeal to the judge to allow him to qualify it, or add to it any matter within *his own knowledge* and which is at the same time relevant to the case. The witness must remember that he takes an oath to state the truth, *the whole truth*, and nothing but the truth. On the other hand, while the counsel for the defence is bound not to introduce falsehood, his object is *not* the discovery or development of truth. Unless the witness is on his guard, he may find that his affirmatives and negatives may be worked into a shape representing the reverse of what he intended, when the learned counsel who has cross-examined him addresses the jury.

Some counsel adopt the ingenious plan of compressing two or three questions into one. A witness unthinkingly answers the last, or that which most fixes his attention. The same answer may not be strictly applicable to all, but the witness may find, when too late, that it is made so in the defence. In this case he should ask for a severance of the questions and give separate replies.

Direct answers are necessary, because it is only by them that the case can be brought clearly before the Court and jury in all its details. Medical witnesses sometimes forget this, and fall into answers to questions floating in their own minds, or which they think are likely to be put to them. They are

also sometimes disposed to anticipate many questions by one general answer. This simply creates confusion, and the witness will be told by counsel to keep to the question, and that he is coming to the other matters presently.

In a case involving a question of compensation for personal injury as a result of a railway accident, tried at the Autumn Assizes of 1865, medical witnesses were called on both sides. The reporter of the trial observes, in reference to the evidence of one of the medical witnesses for the plaintiff: 'In the course of a long cross-examination, this witness appeared to avoid giving "direct" answers to the questions put to him, and to affect to misunderstand them, to such an extent as to draw from his lordship the remark, "Do pray, Dr. ——, be a little more candid."' From some judges a witness thus acting would have met with a much more severe rebuke. A witness should remember, at all times, that he takes an oath to state the *whole* truth.

Care should be taken by the medical witnesses not to argue with the learned counsel. Argument is not evidence, and the entering into it disturbs the order of the proceedings. Arguments between counsel and witnesses, and even between medical witnesses themselves, are freely allowed in the French Courts, but in England such a practice is not recognized. The mode in which questions are put by counsel in cross-examination sometimes tends to the introduction of argument, but the witness should avoid the temptation to enter into it. What he says under such circumstances is not evidence, except in the form of answers to questions, and he is there only for the purpose of stating what is relevant to the case.

There is a difference between evidence and testimony. A medical witness sometimes gives much in the form of testimony which amounts to very little as evidence. When he does not attend to the questions, he testifies to a variety of subjects which have no bearing on the case, and do not constitute evidence. The decision on what is and what is not evidence lies with the judge.

2. The replies should be concise, distinct and audible, and, except where explanation may be necessary, they should be confined strictly to the terms of the question. An experienced barrister on one occasion felt it necessary to give this advice to a witness: 'Reflect before you answer, and answer so that you may be heard.' A judge generally takes full notes of the medical evidence: he has first to hear, secondly to understand, and thirdly to write down the replies of the witness.

Some witnesses have a singular habit of not answering the question which is asked, but one which is not asked. In reference to this practice which generally arises from a want of proper attention to the question, a learned judge made the following remarks: 'When a witness does not answer a question, but answers something else, it leads persons accustomed to Courts of Justice to believe that he prefers not to answer the question but to put a different point upon the counsel.' Again, we meet with witnesses who begin to answer before the question is completed. Some are concise from a dread of saying too much, while the answers of others are given in such a voluble form, in the shape of a small speech or lecture, that there is great difficulty in reducing them to their proper proportions. A witness who is so profuse of information generally supplies abundant matter for a long and troublesome cross-examination.

It has been a question whether a witness should volunteer evidence, assuming that the examination-in-chief and cross-examination have not brought out all that he knows of the case. If that which he has to state is some matter of fact within his own knowledge, or an opinion based on facts within his knowledge, he will be allowed, on application to the judge, to make the statement in spite of the efforts of counsel on either side to shut it out.

It is scarcely necessary to observe, that the language in which the answers are returned should be plain and simple. Counsel who are unacquainted with medical terms frequently misapply them, or use them in a wrong sense. There are few barristers who are aware that the term 'symptom' is confined to the living body, and 'appearance' to the dead; and the witness may thus find himself questioned on the 'appearances' when he first saw the patient, or the 'symptoms' which he observed on the post-mortem examination of the stomach and bowels. On a trial for murder, in which one of the questions at issue was whether dysentery or poison was the cause of death, the learned counsel puzzled one of the medical witnesses by asking him whether during his attendance he found any traces of '*dysuria*' in the fæces! There is no doubt he intended to refer to a state of the fæces like that met with in dysentery, but the professional term employed by him signified a 'difficulty in passing urine.' A judicious witness will avoid anything like a triumph over his examiner under such circumstances, and simply put him right.

3. Answers to questions should be neither ambiguous, undecided, nor evasive. An ambiguous answer necessarily leaves the witness's meaning doubtful, and calls for an explanation. An undecided answer—indicated by the words 'I believe,' 'I think,' 'It might be,' or 'My impression is'—is not sufficient for evidence. Did the wound cause death? Was death caused by loss of blood or poison? If, by a proper consideration of all the medical facts, the witness has come to a conclusion on the subject, his answer should be expressed in plain and decided language, either in the affirmative or negative. A man who has formed no conclusion is not in a position to give evidence. No opinion should be given for which the witness is not prepared to assign reasons, and, except by permission of the Court, no medical opinion should be expressed on facts or circumstances observed by others. A hesitating witness will be met with the question, Have you any doubt about it? or, Was it so or not?—to which a reply in the affirmative or negative must be given. If the witness fairly entertains doubts about the matter at issue, it is his duty to express them at once, and not allow them to be extorted from him piecemeal by a series of questions.

Chemical witnesses have occasionally certified to the discovery of 'imperceptible,' 'unmistakable,' or 'undoubted' traces of poison in the liver, &c. Such terms naturally convey to the shrewd mind of the examiner that the witness has some lurking doubt or suspicion of mistake in his mind, for that of which we are sure requires no such terms to express our meaning. If poison has been discovered, the statement of the fact is sufficient.

4. The replies should be made in language free from technicality and exaggeration. Some remarks have been elsewhere made in reference to the use of technical terms in drawing up medico-legal reports. If medical men could be made aware of the ridicule which they thus bring on their evidence, otherwise good, they would at once strive to dispense with such language. A witness is perhaps unconsciously led to speak as if he were addressing a medical assembly, instead of plain men like the members of a common jury who are wholly ignorant of the meaning of medical terms, and barristers who are but imperfectly acquainted with them. Thus a medical man will speak of an 'exacerbation' instead of 'increase' of symptoms, of the 'integuments of the cranium' instead of the 'skin of the head,' while a common cut is invariably described as an 'incision,' and a black eye as 'a tumefaction of the orbit.' On a trial for an assault which took place at the Assizes some years since, a medical witness gravely informed the Court that on examining the prosecutor, he found him suffering from a severe contusion of the integuments under the left orbit, with great extravasation of blood and ecchymosis in the surrounding cellular tissue, which was in a tumefied state. There was

also considerable abrasion of the cuticle.' *Judge*: 'You mean, I suppose, that the man had a bad black eye?' *Witness*: 'Yes.' *Judge*: 'Then why not say so at once.' This most erudite and classical description of the injury was at once resolved by the judge into two plain Saxon words, the meaning of which every one in Court could understand. In a case of child-murder, a medical witness who was asked to state simply the cause of death said that it was owing to 'atelectasis and general engorgement of the pulmonary tissue.' This is not science, but pedantry; and if such language is employed by a witness with a view of impressing the Court with some idea of his learning, it wholly fails of its effect. Barristers and reporters put down their pens in despair, and the time of the Court is wasted until the witness has condescended to translate his ideas into ordinary language. Lord Hatherley well observes that 'a scientific witness in giving his evidence should avoid as much as possible the use of technical scientific language, especially if the case is before a jury. This is especially desirable when the evidence is medical, for really many technical words in medicine seem to be invented to cover ignorance. But be this as it may a witness is always suspected of affectation, and the Court and jury are but little instructed when a vast amount of learned phraseology is poured forth instead of a clear statement of the witness's opinion.'

5. In giving evidence of *opinion* a medical witness must take care not to base it on any statements made by others, or on circumstances which may have come to his knowledge by public rumour. Again, his evidence should be confined only to subjects properly within the range of medical science, and on which, as a professional man, he is competent to speak. In a trial for murder by wounding, in which the identity of the prisoner was in question, a medical man stated that he compared certain footmarks with the boots taken from the prisoner, and he found that they corresponded. A comparison had also been made, but not at the same time, by a police-officer, more accustomed to matters of this kind. On cross-examination, there was such a want of agreement between the surgeon and the constable respecting the number of nails in the boots and the number indicated by the footprints, that no reliance could be placed on this portion of the evidence. In reference to this discrepancy, the learned judge remarked that a medical man should confine himself to matters belonging to his own profession, and not take upon himself the duties of a police-constable. There are some points in reference to gun-shot wounds which can be better explained by a gun or shot-manufacturer than by a medical witness—*cuique in suâ arte credendum.*

Exaggerated language should be avoided. There is a great tendency among some medical witnesses to express their views in the superlative degree. If a part is simply inflamed, it is frequently described as 'intensely' inflamed. One witness may speak of patches of ulceration in the intestines, another will describe the same condition as 'extensive ulceration.' On a trial for murder by poisoning, a witness when asked by the Court as to his experience of the effects of the poison on man and animals, said that he had seen 'some dozens of cases.' These 'dozens' on cross-examination as to time, place, and circumstances, were reduced to the modest proportion of about six to eight cases. This use of exaggerated language often leads to apparent conflict in medical testimony. It is not creditable to the witness, and throws a doubt upon the whole of his evidence.

The use of Notes in Evidence.—This subject will be more fully considered in another part of the work.

Medical Experts.—In cases of a complicated nature and involving important interests, it is customary to call in medical or scientific experts, who, by

reason of their special experience in certain branches of the profession, are presumed to be able to guide the Court to a proper understanding of the facts of the case. In questions of legitimacy or divorce, obstetricians of high standing are consulted on both sides; in questions affecting the sanity of persons, those who have acquired a reputation in the treatment or observation of the insane are selected; in the various obscure injuries resulting from railway accidents, surgeons of repute,—and in questions of life-insurance, physicians of high standing are summoned as experts to give the results of their experience. There are many of these cases, including some in criminal law, which could not possibly be settled without this collateral aid—the questions at issue not being based on matters of fact occurring within the ordinary range of practice, so much as on an enlarged experience in a particular department. There is, however, a strong public feeling against the admission of the testimony of experts. One able writer remarks:—'It is impossible to shut out such evidence altogether, but there is nothing which brings more discredit upon the administration of justice. There is one consequence of its admission which is common to all cases in which it occurs: it is, that no difficulty has ever been found in obtaining any amount of evidence of this description, on either side of any point in issue. There is a contest as to whether a vitriol or a gas manufactory is a nuisance. Twenty chemists of fair character and scientific acquirements come forward to swear that the effluvia evolved by these processes are producing the most deadly fevers, and twenty others equally eminent will give just as positive testimony that the gases are absolutely wholesome, and rather fattening than otherwise. These things are of everyday experience.

It will frequently be the duty of a medical expert, in civil as well as in criminal cases and in all actions for malapraxis, to pass an opinion on the practice of another professional man. On such occasions, while there should be no suppression of the truth, a witness is bound, in answering questions put to him by counsel, to state his opinion and the grounds on which it is based clearly and distinctly. It may be hard to condemn a brother-practitioner, but it would be still harder to ignore the public interest, and condemn ourselves and our profession by concealing that which we know to be true, or by suppressing what we honestly believe. There is no etiquette in the profession which demands such a sacrifice of principle as this conduct involves. A medical witness is not bound to be forward in pointing out and suggesting defects, or in endeavouring to lower another practitioner in the opinion of the public; but nothing should be concealed which is relevant to the elucidation of the case in issue. The golden rule, 'Do unto others as you would that they should do unto you,' should be strictly observed on these occasions.

Certain lunacy cases and cases of compensation for bodily injury by railway accidents, have drawn particular attention to the testimony of experts. Lord Westbury, in referring to experts in lunacy in the *Windham* case, remarked that they came forward to swear away the sanity of persons, and when their reasons were examined it was found that persons asserted to be insane could not answer questions which some of the witnesses themselves were unable to answer. 'The absence of explicit statement,' said Lord Westbury, 'was abundantly made up by a flow of hard names, which no doubt had great weight with the jury. "I should call unsoundness of mind a mixture of chronic mania and *dementia*," said one doctor; "speaking in popular language, I should call it a mixture of mania and fatuity occurring in a person once having a sane understanding." Another learned physician examined the same lady, no doubt with great cleverness, and thought he would try her knowledge of law. He therefore asked her several questions about the Constitution, but when similar questions were addressed to him by counsel he

himself betrayed considerable uncertainty and hesitation. In the examination of an alleged lunatic in another of these cases, she was asked how much 100*l.* a-year would give per week; she was not able to tell, and this was relied on as a proof of her insanity; but upon cross-examination of the medical man who was giving evidence of her lunacy, he was asked whether he himself could tell how much per week 100*l.* a-year would give: he hesitated. He was then asked whether he did not know or declined to tell; his reply was that he declined to tell.'

It cannot be denied that experts have frequently introduced into their evidence speculative fancies and idle theories, not warranted by a proper induction from the facts; but it is quite clear that in all trials requiring special knowledge, if justice is to be administered, a Court of Law must be assisted by those who possess that knowledge. I have elsewhere suggested the cause of the evil, and what I believe would prove a remedy. The cause of the evil is that the solicitors on each side are allowed to search the whole profession, until they can find one or more persons ready to adopt their respective views; and when once in Court, provided a man can call himself a 'doctor,' his qualifications and experience sometimes escape a rigid scrutiny. Persons have thrust themselves or been thrust into cases as experts without any pretensions to such a title, either by their professional standing or experience. A man who may have been engaged for a few years only in the ordinary routine of medical practice, and who may have had no special experience on the subject on which an opinion is required, will be described by his counsel 'as a most learned and eminent member of the profession, on whose opinion the jury are as much entitled to rely as on that of the "highly respectable gentleman" called on the other side,' &c. The nomination of experts as witnesses by the judge who tries a case, or by the Lord Chancellor in his department, would do away with most of the objections which now tell with so much force against their evidence. As long as they can be retained by either party—and the profession is large enough to furnish a great variety of experts—so long will the objections to the present system continue, and the good be confounded with the bad.

Cockburn, C.J., in commenting upon evidence so obtained, observed 'that it was in the nature of things, that those who gave scientific evidence should lean slightly to the side upon which they were giving their testimony, not from any dishonest intention, but from a perfectly natural and human failing, as in such cases a man was apt to look with a keener eye on those things favourable to his own side, than on those which were unfavourable.'

Bovill, C.J., in making some remarks on medical evidence, says: 'The great misfortune or defect in medical testimony hitherto has been that medical men, like many other professional men, have been too much in the habit of making themselves partisans in endeavouring to support the particular views of the parties on whose behalf they have been called, and this has led to conflicts of opinion which have sometimes appeared not very creditable to the profession.' Lord Hatherley thus expresses his views on the subject: 'A witness to facts knows that it would be base beyond measure to bend his evidence so as to suit the case of him on whose behalf he is called, and that his only duty is to state plainly without colour or fencing what he knows as a *fact*. But the witness who gives an *opinion* is selected by the litigant, often communicating with many of the same profession as the witness, and when so selected he is expected to express a particular opinion. He may honestly entertain it when first selected, but then it is like the case of a counsel's opinion: the counsel gives his opinion on the statement of facts submitted to him, but perhaps after hearing the other side he would find the case wholly altered, and would say so. The scientific witness called into

Court by the plaintiff is generally expected to support his case in cross-examination, when many views may be suggested that may really modify the witness's judgment; but even after facts have been proved that ought to modify it, the witness frequently holds to his original opinion. Every witness should eschew altogether the notion of partisanship. He should be ready to give his opinion frankly and unreservedly, regardless how it may tell. He is there, not as an advocate, but in order to inform the Court and jury to the best of his judgment. In fact, I think a judge ought to call in scientific evidence as in lunacy cases, and I doubt whether any *opinion* on oath should ever be given. The jury would then see that it was opinion only—the witness would with more decorum modify his opinion, and would acquire the habit of believing himself to be, not a partisan but an expert, thus rendering assistance of greater value.'

Men of acknowledged skill and good professional experience sometimes quite forget their proper duties as experts, and lay themselves open to censure. An expert is usually called to give an opinion on a certain state of facts laid before the Court in the evidence of other witnesses: thus certain appearances may be described as having been seen in the stomach or brain, and he may be asked to state the conclusions to which such appearances lead. A medical practitioner may describe accurately what he sees, but may not have sufficient experience to draw a correct conclusion. In this case an expert may differ from him and totally alter the bearing of the case. So a man may describe certain symptoms which an expert may say are or are not consistent with poisoning, but he must take care that he does not alter or distort the facts deposed to by other witnesses, in order to fit into the case his own theories or opinions. The alteration of facts to suit special views is by no means unfrequent, and an expert who thus deliberately mangles the evidence of others cannot escape the charge of being a partisan or an advocate in the case—a character wholly inconsistent with that of a witness, who should aim to be in all things impartial. A glaring instance of this kind occurred at the Guildford Summer Assizes of 1862, in an action against a railway company for damages for personal injury. The condition of the plaintiff was accurately described by his medical attendant. Some eminent surgeons who had examined him were called as experts to depose to his present and probably future condition. Other equally eminent surgeons were called as experts on the part of the company, and they differed (as well they might) on the speculative question when the man was likely to recover entirely from the effects of the accident. One of the most distinguished surgical experts for the defence, however, began by saying that plaintiff had only sustained a 'considerable shake;' but shakes are not commonly recognized as surgical accidents, and the surgeon on the other side had described this 'shake,' from actual examination, as a 'concussion of the spine.' But the witness continued—'And as to what was said of congestion of the fibrous tissue, it was mere phraseology not indicating actual facts.' The learned judge who tried the case observed that he could hardly take that as evidence. '*The witness must state facts, or his opinion from facts.*' The witness then *disputed the facts*, but the learned judge told him that he had no right to do so, and that he must *give his opinion on the facts as proved.* In these few words are defined the whole of the duties of an expert who presents himself as a witness. The above example shows clearly what ought to be avoided, and it corroborates an observation elsewhere made that the greatest professional knowledge and skill may coexist with an entire ignorance of the proper methods of employing this knowledge to aid the administration of the law.

Some Chemical experts have shown so little sense of their true position in Court, that at important trials they have not only altered the facts given in

evidence to suit the views of the accused for whom they appeared, but they have described their own analyses as those only on which reliance should be placed. They have claimed almost exclusive experience, if not infallibility, in the scientific matter at issue, and have denounced as incorrect, before a tribunal utterly incapable of forming a judgment on such subjects, the chemical processes of experts of equal standing on the other side! A chemist who was giving evidence as an expert in a patent case, at a trial before the late Baron Alderson, was asked by his counsel whether he had had much experience on the subject then under inquiry. He replied by saying that he had had very considerable experience, more than most chemists, and was apparently about to announce himself before the Court as the sole standard of what was correct in that department of science; when the learned judge interrupted him with the remark—'Do not praise yourself or your proceedings, Sir; the jury will estimate the value of your evidence when they come to consider the whole of the case.' Men who thus act, damage not only the cause on which they are summoned, but they at the same time bring scandal on the evidence of experts in general.

The subject of experts, and the mode in which their evidence should be received, has been ably handled, in a legal point of view, by Mr. Stephen ('Criminal Law,' p. 209). He objects to the proposition of referring scientific questions to them, even when nominated by the Court, and he considers a common jury better qualified than experts to deal with and decide on all points of scientific evidence. One of the reasons which he assigns for his objection will probably surprise the medical reader: it is, that experts so nominated and employed, i.e. as assessors to the judge and in the absence of a jury, would *only direct their minds to the truth.* 'A juror,' he observes, 'is not a scientific inquirer, but a judge bound by oath to say whether or not certain evidence satisfies his mind; a scientific inquirer is not bound by anything of the kind.' He considers the suggestion to be based on a misapprehension of the result to be reached and the mode of reaching it: 'It assumes that the object of the inquiry is the attainment of truth simply, and that scientific men are more likely to attain it than others. To this it may be replied, that the result to be reached is not truth simply, but such an approach to truth as the average run of men are capable of making, and that the result is more likely to be found in the opinions of common than scientific jurors.' (loc. cit.) On this it may be observed, that while experts have the same power of dealing with common things as common jurors, they have an additional special power of making that approach to truth on scientific subjects, which common jurors certainly do not possess. It would also appear from this reasoning, that in a judicial inquiry affecting a person charged with murder, something less than truth is more satisfactory for the purposes of justice than truth itself!

But the question regarding this employment of experts as assessors, and the avoidance of the imputation of their appearing as hired retainers in a case, is practically answered in the Admiralty Courts. Four Masters of the Trinity House, experienced in all the rules of navigation, give their opinions on questions submitted to them, as nautical experts, by the Court; and without creating any charge of injustice in the decisions of the Court, they constantly guide these decisions by answering certain difficult nautical questions. In a case in which two ships come into collision, both parties contend they are right, or the case would not be litigated. The question turns upon the respective positions of the ships, the setting of certain sails, the direction of winds, tide and currents, and whether the helm should have been ported or starboarded before the collision. These nautical experts, as their opinions are now received, acquit themselves with satisfaction; but if such a trial took place before a jury, and each captain

was allowed to select his own experts as witnesses, there would be the same dissatisfaction as that which now exists in reference to trials involving other branches of scientific evidence. On this subject a writer justly remarks:—'It is true that in all trials requiring special knowledge the Court must be assisted by those who have that knowledge. But it would contribute very much to the morality of science and to the due administration of justice if this assistance were not allowed to be given by witnesses hired and brought forward by the parties. The inconvenience has been provided against in some cases with admirable effect. In the Lunacy Commission the visits are made throughout the kingdom by barristers and physicians associated in pairs, the one educated to the investigation of law and facts, the other to the diagnosis of diseases. This has worked admirably. So in shipping cases, where it is necessary that the Court should be assisted by nautical knowledge, the Elder Brethren of the Trinity House are not put into the witness-box by the parties to the suit, but are placed on the Bench, and act with judicial responsibility. In all cases we think that the light which science can throw upon the question should come not from a witness who is paid to refract it, and who, if his judgment or his conscience will not allow him to make it tell for his client, is not called, but from a man who has no bias, who is chosen either by both parties or by the Court, and who is rather an assessor than a witness. In lunacy cases the presence of one or more of the physicians of the Lunacy Commission, sitting with the judge, and aiding the jury in their examination, would be of more value than the evidence of a hundred madhouse-keepers.' Some sensible remarks on this subject, made by a Medical Committee of the American Academy, will be found in the 'Medical Times and Gazette,' 1870, 1, 370.

There can be no doubt that the present system discourages some eminent and upright men, who could by their special knowledge solve many important questions, from appearing as witnesses. I am and have been acquainted with several who have uniformly refused on this ground to attend as experts in a Court of Law. A distinguished chemist, now deceased, a gentleman of strict honour and integrity, was once asked by counsel—in the first question put to him in cross-examination, 'When and by whom were *you* first *retained* in this case?' Without directly imputing bribery and perjury to the witness, the innuendo to the Court and jury was to the effect that this gentleman had, like a lawyer, received his fee to maintain a client's cause, wholly irrespective of the oath which he had taken. As counsel on both sides look on the experts opposed to them in the light of hired advocates, it is obvious that so long as this system lasts, it must have a deterring effect on the higher and better class of witnesses, who, whenever they have the option, will avoid placing themselves in such a position as to have imputations of venality and untruthfulness thrown out against them in a public Court. In a correspondence with the late Dr. Andrew Combe of Edinburgh, many years since, he informed me that he had been consulted in a case in which a gentleman was considered to be incompetent to manage his affairs. He says in his letter: 'I was required to go and examine him on twenty-four hours' notice, but I insisted first on receiving some account of him, and being allowed to form an unbiassed opinion of the results of the examination. With some difficulty I obtained his history, and on perusing it saw a strong probability that my opinion would be adverse to those who consulted me. They of course professed pure impartiality, but it was manifest that my opinion was expected to confirm theirs. Had I been called by the sheriff, for example, I might have given impartial evidence.' The late Dr. Baly, Dr. Munro, Dr. Wood, and myself were required to give our opinions in a similar case. We insisted upon being allowed to make a full examination of the alleged lunatic, and the result was that our opinions

were completely adverse to those who consulted us, much to their disappointment. We declined to give evidence in the case. It is a fact worthy of note, that in criminal trials, where life is concerned, no provision is made by the English law for enabling a judge to take the opinions of one or more medical or scientific experts, not connected with the case, although such a practice would be attended with great public benefit. If there is conflicting medical evidence he can only direct an acquittal. In reference to actions for railway accidents the law has interposed. By an Act passed in 1868 (31 and 32 Victoria, cap. 119, sec. 26) it is enacted that, 'whenever any person injured by an accident on a railway claims compensation on account of the injury, any judge of the Court in which proceedings to recover such compensation are taken, or any person who by the consent of the parties or otherwise, has power to fix the amount of compensation, may order that the person injured be examined by some duly qualified medical practitioner named in the order, not being a witness on either side, and may make such order with respect to the costs of such examination as he may think fit.' This power was recently exercised by Kelly, C.B., in a railway case tried in the Exchequer, December 1871. Three physicians were examined and gave their opinions on the degree of injury sustained. An eminent surgeon, who had not been consulted in the case, was required under the judge's order to draw up a special report from the facts proved in evidence. This report was given in evidence, and confirmed the statements of the witnesses for the plaintiff; a verdict was given accordingly. Such a principle should be extended to all cases involving criminal charges and requiring medical or scientific evidence for their elucidation.

Medical Counsel.—Some barristers, who feel themselves unable to discuss the medical bearings of a question, are in the habit of employing medical men to instruct them on the best mode of endeavouring to baffle medical witnesses, so as if possible to place the case in an equivocal light before a jury. In short, there are some in the profession always ready to act as medical counsel, and to be 'retained' for the prosecution or defence, as the case may be. It is obvious that even if interference were prudent, under the present system of summoning medical witnesses, the law could not interfere to check a practice which is certainly liable to lead to evil results; for the parties who give the suggestions which may suit the purpose of an advocate do not always act as witnesses, and therefore cannot have their own means of knowledge or sources of experience fairly tested, while the *selected* medical facts or opinions which they may communicate to the advocate may have the intended effect of confusing the minds of the jury. Under these circumstances, the result must depend on the acumen and medical knowledge possessed by the judge who tries the case.

The question has been frequently asked, May not a medical witness honestly take up the defence of a prisoner? Is it always certain that the case for the prosecution is indisputably correct? The latter question admits of a simple answer, which will show the course that may be fairly pursued. The evidence for a prosecution may involve a serious medical error, as well as the evidence for a defence. Assuming, from his knowledge of the ascertained facts of the case, a witness believes *bonâ fide* that the medical opinions for the prosecution are incorrect or contrary to his own experience, he has a right to interfere and point out what he considers to be an error of fact or opinion. What he has to state, however, in this behalf should be publicly stated on oath, so that his experience, motives, and honesty of purpose may be fairly and openly tested by a cross-examination. He should remember that his interposition is only justifiable in the interests of justice as well as of the *public*, and not in the personal interest of the accused. If he is retained and paid

by the prisoner's legal advisers to defend the prisoner's interest, wholly irrespective of the public interests, he is simply a medical counsel or advocate, and any professional opinions which he gives in the witness-box should be rejected on the principle that no advocate should be a witness and no witness an advocate. Under these circumstances his evidence is given for a special purpose and paid for accordingly, and it would be contrary to human nature to suppose that a witness so situated could give those free and unbiassed opinions which are requisite for the guidance of a jury. It is this kind of interference, on the part of some medical and scientific witnesses, which has laid the whole profession under a general censure. When, as in certain criminal trials, men thus hire themselves solely for the purposes of a defence, *i.e.* to rescue an accused person from the penalty due to a crime which there may be strong reason to believe he has committed, they may justly be called, in the language of a great lawyer, traffickers in evidence. It is not surprising to find that evidence should be manufactured on such occasions to meet the requirements of the defence. In one important case (*Reg.* v. *Tawell*, Aylesbury Assizes, 1845), a woman died from the effects of prussic acid, and a fatal quantity of that poison, amounting to one grain, was clearly discovered in the stomach of deceased by an experienced chemist. As, from the moral and circumstantial evidence, the guilt of the man could scarcely be disputed, an attempt was made to destroy the effect of the chemical evidence, and to impose on the common sense of the jury, by the statement that the deceased had eaten some apples, that the pips of apples contained the principles for producing prussic acid in the human stomach, and that the poison found in this case had resulted wholly or in part from the apple-pips! This monstrous chemical proposition met with no acceptance from the jury; they preferred the doctrines of common sense to this pseudo-scientific theory. The interference in this case for the defence, could not have been based on any *bonâ-fide* belief that the chemical evidence for the prosecution, on which the conviction of the prisoner chiefly turned, was untrustworthy. The inventors of this hypothesis had not the excuse that public justice, or the life of an innocent man, was in danger from any medical or chemical error; and the only other object which can suggest itself is, that they worked to procure the acquittal of the prisoner by endeavouring to mystify the jury and mislead the Court on a simple scientific fact. A striking instance of an attempt to deceive a jury in a civil case, by manufactured chemical evidence, occurred a few years since under my observation. An action was brought against a Company for alleged damage to cattle by the smoke of a flue connected with some lead-works. It was said that plaintiff's cattle had been poisoned to a great extent by the deposit of lead on the herbage for a great distance around. The grass, shrubs, hedges, &c. on the plaintiff's ground underwent an inspection or a view before the trial, by chemists on both sides attended by some members of the special jury; but no deposit of lead could be seen anywhere, nor was any pointed out to those who attended on the part of the defendants. During the trial in Court, however, a branch recently cut from a tree was produced, and this was covered by a well-marked white deposit (white-lead), concerning which there could be no doubt whatever. The chemists on the part of the Company, however, made this observation—the under-surfaces of the leaves were as much covered with white-lead as the upper surfaces—a circumstance not consistent with the supposed deposit from a flue. But a still more surprising condition was noticed—the *cut surface* of the branch was as much covered with a white deposit as the bark and leaves. It was impossible to admit that this could have arisen as a deposit from a flue, and the facts appeared to be only explicable on the theory that a branch of a tree had been cut off and secretly dipped into the defendant's lead-washings and

dried—the person who performed this experiment not having been sufficiently careful or thoughtful to keep out of the water the cut end of the branch! This would probably have gone to the jury as evidence of a deposit of lead from the flue; but, as the subject had attracted the special notice of defendants' witnesses, those who were interested in the plaintiff's case quietly withdrew the branch and thrust it under the table of the Court. Such practices are not calculated to give a high value to chemical evidence; but I believe conduct of this kind to be quite exceptional.

In civil cases it is not always easy to say, until the evidence has been heard in Court, whether scientific opinions should be in favour of plaintiff or defendant; and herein lies the great advantage arising from the opinions of scientific experts employed as assessors. There may be on each side a portion of truth which will meet with its medical supporters, without any imputation upon their motives, any more than upon the motives of the members of a special jury, who, in spite of perfect absence of bias, cannot always agree. Nevertheless there are some plain matters of fact in which it is discreditable to the profession to find disagreement. If medical science is of any value for the guidance of a country, it should be able to determine whether a man is or is not labouring under paralysis as the result of accidental injury. In the following case (*Sherwin* v. *N. E. R. Company*, Leeds, Lent Assizes, 1872) an equal number of medical witnesses supported opposite views. In this case the plaintiff claimed damages for personal injuries. He was described as a strong healthy man up to the time of the accident. The negligence was admitted, and the plaintiff was examined by three medical gentlemen on each side. The three witnesses for the plaintiff stated that he had paralysis of the legs, which was extending upwards, and was of a permanent character, so that he would not be able to walk again. The three medical gentleman called on the part of the defendants deposed that the plaintiff was not suffering from paralysis at all! The jury found a verdict for the plaintiff, damages 1,000*l.*

In cases in which medical men summoned as witnesses lend themselves as advocates to the party consulting them, for the purpose of weakening or overthrowing the scientific evidence on the other side, in spite of its consistency and accordance with sound medical doctrines, they lose sight of their true position, and justly expose themselves to severe censure. If, on hearing the evidence to facts on the side of the party consulting them, they find the complexion of the case altered, and that they cannot support it as they believed they were in a position to do, it is their duty to themselves and their profession as well as to the public interests—which are always superior to private interests—to withdraw from the case. No man should ever appear to support that which he does not believe to be true.

Actions for compensation in railway accidents have brought to light some practices among certain members of the profession which have repeatedly called forth the censure of the Bench. These persons have allowed themselves to be retained by the Company as surgeons to attend on those who have suffered injury; they have then been employed to suggest terms for compensation, so as to avoid litigation, and if possible to keep the case out of Court. So far no public injury may possibly accrue, although the financial part of the transaction is in the province of an attorney, and not of a surgeon; but when the case comes to trial, the matter assumes an entirely different aspect. The medical attendant of the Company, who has seen the injured plaintiff, but in the interest of the Company, and can probably give the best evidence of the injuries which he has sustained, is so situated, that anything which he may say will necessarily have the taint of bias and self-interest. Medical men have thus been strongly condemned by judges for degrading their pro-

fession by lending themselves as money agents for the defendants. A case of this kind (*Lee* v. *Yorkshire Railway Company*) led to some severe but just remarks on this medical trafficking in accidents in the Court of Vice-Chancellor Malins ('Med. Times and Gazette,' 1870, 1, 733).

Other practices, too, of a more remarkable nature have come to light. In a reported trial of this kind, which took place during the Summer Assizes of 1865, there was a conflict of medical evidence respecting the condition of the plaintiff, the witnesses on one side taking the view that he had sustained serious injury, and those on the other that he was either shamming or greatly exaggerating his symptoms. One medical witness, who adopted the shamming theory, and who appeared on the part of the Company, had attended the plaintiff and prescribed for him, as an experiment, syrup and water, under which it was stated he improved! This satisfied him that the man was shamming. It appeared, however, in cross-examination, that although the witness was paid for his services by the Company, he knew that the plaintiff believed at this time that he was acting as his own medical attendant. This mode of getting up scientific evidence for the Company was justly and severely condemned by the learned judge who tried the case. A medical man's own judgment should suffice to prevent him from falling into errors like these; he thereby not only damages himself, but the profession of which he is a member. Men who adopt these practices should know that they are not in a position to give unbiassed evidence, and therefore should decline to appear as witnesses.

Medical counsel and medical witnesses are differently placed in relation to a case under investigation. While the medical counsel may have undue weight given to his suggestions, in their being put boldly forward by the barrister who retains him, in forcible and impressive language, as ascertained medical truths, he entirely escapes that searching examination into his competency which is infallibly the lot of a medical witness; and again, while the latter is bound by his oath, without reference to the prosecution or defence, to state the *whole* truth, the former is only obliged to give so much of the truth as may suit the case of the party for whom he appears. In short, like a barrister, he is not an advocate of any abstract principle of justice, but of the cause of his client. How far a medical man has a moral right to make use of his professional knowledge in order to embarrass the testimony of those of his professional brethren who are compelled by law to appear and give evidence to the best of their ability, is an ethical question which it is here unnecessary to consider; but there can be no doubt, that while in some few instances the practice may work well, by preventing convictions from taking place upon erroneous opinions, it is liable in most cases to be perverted to the worst purposes. An unscrupulous man, who chose to make himself thoroughly acquainted with scientific subjects, might in this way so pervert the medical facts of a case, and lead to the confusion of witnesses who are not able to cope with him, as to procure an acquittal in face of the most convincing proofs of guilt. The remedy for this evil is in some measure with the medical witness himself. By having his mind fully prepared on the subject before entering the witness-box, he will have no occasion to fear an encounter with members of his own profession, thus disguisedly working against him. A plain statement of the whole truth, with the fact that he shows by his evidence that he has no end to serve but the public good, will enable him to put down the sophistry, medical or legal, that may be thus arrayed against him.

It has been strongly stated that no man acting as medical counsel or adviser should on any occasion be allowed to act in the capacity of a witness. Undoubtedly a man who takes up a case with a view of dressing up the facts for one side only, and collecting evidence for defeating by mystification the

case on the other side, is not in a position to act as a witness with any credit to himself, to his profession, or to those who summon him. His object is neither truth nor an approach to it, but rather the gaining of a victory *per fas aut nefas*. There is no law by which such persons can be prevented from acting as witnesses; but, as a rule, their evidence is either rejected or received with great distrust. Their conduct also, if carried on openly in Court, might give rise to severe comments from the judge and opposing counsel. In some cases the cross-examination of such persons would be a benefit, since it might have the effect of showing that many of the questions which they had suggested in the case were based upon erroneous views, on ignorance of the real facts, or on actual want of experience. A medical witness may, without any imputation upon his *bona fides*, explain medical points to counsel, and correct him on medical subjects when wrong in his views or statements; but he should avoid even the appearance of prompting counsel in the conduct of a case.

Conflicting Medical Testimony.—The conflict of opinion among medical witnesses and medical experts is a favourite theme of comment with a portion of the public. The reader will find some remarks on this subject in reference to Commissions of Lunacy. I have little to add to them, for similar remarks apply to all medico-legal cases which come before a Court of Law. That men should be found who can traffic in evidence is certainly a misfortune for the profession to which they belong, but differences of opinion on the same state of facts may fairly exist in the medical as well as in any other profession. If such differences come more before the public on medical or scientific questions, it arises from the fact that the cases demanding such evidence are far more numerous than those which affect the two other learned professions. In suits which involve the rights and duties of the clergy, there is seldom agreement among those who have to decide upon them as ecclesiastical authorities. So among members of the legal profession, and in the administration of justice generally, while barristers notoriously differ and give conflicting written opinions upon the same state of facts, special jurors, consisting of highly-educated men, are unable to agree in opinion, and are often discharged without a verdict, to the great injury of litigants. If in an important patent case, after a series of appeals, learned judges themselves differ *toto cœlo* in the construction of the law, and are obliged to read conflicting written judgments *seriatim*, it may be surely permitted to scientific men also to differ conscientiously from each other without any imputation of interested motives. The fact that the venal evidence of 'hired' experts or witnesses occasionally finds its way into a case, does not justify the sweeping denunciation of medical or scientific witnesses as a body. As Mr. Stephen remarks of the Law, so it may be said of Medicine—no system of rules can fully embody that line of conduct by the observance of which those who exercise a noble profession with honour and credit are distinguished from those who disgrace it. It is purely a matter of sentiment and good feeling.

It is truly a sad day for science, as one learned judge remarked, when the conflict of opinion may be traced to the ignoble motives of a desire of gain or of notoriety, or of anything but a desire for truth. In a memorable trial, which took place at the Central Criminal Court, in 1856, the conflict of medical testimony was considered to have reached its maximum degree. The only question at issue was—'Death from strychnia or disease?' If the former was true, the guilt of the prisoner could not for one moment be questioned, as it was in evidence that he alone had given to the deceased the food and medicine which he took on the day of his death. The suggestion of suicide or accident could not be entertained. On the main fact, however, the conflict

of testimony was only apparent, not real, since one of the principal scientific witnesses for the prisoner admitted, when cross-examined by the learned Attorney-General on the part of the Crown, that he had again and again asserted that this was a case of poisoning by strychnia, but that the scientific witnesses for the Crown had not known how to find the poison in the body of the deceased. If this was his honest conviction from the facts known to him, it was obvious that he was voluntarily placing himself in a false position in coming forward as a witness for the prisoner. In so appearing, however, and in taking an oath to state the *whole* truth, his evidence should have been to this effect: 'I am of opinion that the deceased died from strychnia; no person can possibly die from strychnia without some portion of the poison necessarily remaining in the dead body. It was not found in this case, because the chemical witnesses for the Crown did not know how to find it. By my process I could have detected strychnia in this body.' Had this straightforward course been adopted, the Court and the public would have seen at once that in the most material part of the case (death from poison) there was really no conflict of testimony. The jury, as this witness well knew, were not there to decide upon the relative ability of chemical experts, or on the best process of analysis for detecting strychnia, but simply whether the deceased did or did not die from this poison. The remarks of the learned Attorney-General upon the evidence of the witness who had thus compromised himself convey in a few words a fair warning to all medical counsel who are inclined to imitate such an example as this:—

'I have seen *that* gentleman (referring to the expert) not merely contenting himself with coming forward, when called upon for the purposes of justice, to state that which he knew as a matter of science or of experiment, but I have seen him mixing himself up as a thorough-going partisan in this case, advising my learned friend, suggesting question upon question, and that in behalf of a man whom he has again and again asserted *he believed to be a poisoner by strychnia.* I do not say that that alters the fact; but I do say that it induces one to look at the credit of such witnesses with a very great amount of suspicion. I reverence a man who from a sense of justice and a love of truth—from those high considerations which form the noblest elements in the character of a man—comes forward in favour of one against whom the world may run in a torrent of prejudice and aversion, and who stands and states what he believes to be the truth; but I abhor the traffic in testimony to which I regret to say men of science sometimes permit themselves to condescend.' (Report of Trial of W. Palmer, p. 287.)

From these remarks, a medical witness will learn not only what he ought to do, but what he ought not to do, in taking up the defence of a person who is charged with crime. The scandal attending such displays as these, whether considered in relation to science or jurisprudence, may, it appears to me, be removed either by the appointment of experts as assessors to the Court, or by giving a power to the judge to summon to his assistance, in all cases of importance, independent scientific witnesses.

QUESTIONS CONNECTED WITH THE DEAD BODY.

CHAPTER 3.

QUESTIONS CONNECTED WITH THE DEAD BODY—SIGNS OF DEATH—CESSATION OF RESPIRATION AND CIRCULATION—APPARENT DEATH—TRANCE—COLDNESS OF THE BODY—POST-MORTEM HEAT—RIGOR MORTIS—CADAVERIC RIGIDITY—CIRCUMSTANCES WHICH INFLUENCE ITS COMMENCEMENT AND DURATION—OTHER INDICATIONS OF DEATH.

AMONG the subjects which sometimes claim the attention of a medical jurist, in reference to the bodies of persons found dead, are the conditions known as real and apparent death, the proofs of death, and the priority of death. A knowledge of the changes which take place in the dead body at a recent, as well as at a remote period, may be usefully applied to the determination either of the reality of death, a problem seldom involving difficulty, or of the period at which death took place, a question of considerable importance, and upon which the guilt or innocence of an accused person may frequently depend. Medical jurists have enumerated certain external signs or indications of death. It will be necessary to consider these in the order in which they commonly present themselves to the observer.

1. CESSATION OF CIRCULATION AND RESPIRATION.—The cessation of these two important functions is regarded as, in itself, sufficient to determine the reality of death. But persons have been resuscitated from a state of asphyxia; and others again have recovered from a state of lethargy or catalepsy, when to all appearance, the respiratory and circulating processes had been completely arrested. Life is not certainly incompatible with a temporary suspension of these two important functions; but, in making this admission, it is undeniable, that the processes must be speedily re-established, or death will assuredly follow. One remarkable case illustrative of the maintenance of life under a partial suspension of the action of the heart and lungs, is recorded by Dr. Cheyne. It is that of Colonel Townshend, who appears to have possessed the power of voluntarily dying:—*i. e.* of so suspending the heart's action, that no pulsation could be felt. After lying in this state of lifelessness for a short period, active life became slowly re-established; but without any volition or consciousness on his part. The longest period during which he remained in this inanimate state, was about *half an hour*. It is probable, however, that the heart's action was not entirely suspended during the whole of this time, but that respiration and circulation were feebly continued at intervals; so slightly as to be imperceptible to the examiners, or to be indicated by a pulsation of the radial artery. The stethoscope had not been then invented, and the method of detecting the sounds of the heart by auscultation was wholly unknown. A hybernating animal would appear to be dead under similar circumstances, but it is known that circulation and respiration still continue in a sufficient degree to maintain life. M. Bouchut has proved that during hybernation, an animal is simply in a state of apparent death. The vital functions are not arrested, but are reduced to their lowest ebb. Thus he found, in his experiments on the marmot, or mountain rat, that when the animal was in an active state, the pulsations of the heart were 90; while in the torpid state they were reduced to 8 or 10 in a minute. ('Ann. d'Hygiène,' 1848, 2, 96.) In the case of Colonel Townshend, it is obvious that the

action of the heart may have continued, although the pulse at the wrist and other parts of the body failed to indicate it. It appears that the Colonel really died nine hours after the performance of the experiment above mentioned. His body was carefuly examined, but nothing could be detected to account for the extraordinary power which he possessed over the action of the heart. This case, which rests upon good authority, must be regarded as altogether exceptional. It may, however, serve to throw some light upon the possible survivorship of persons, who have been exposed to death by drowning, and whose bodies may have been immersed in water for an unusual period of time.

In some works on the subjects of apparent death and asphyxia, cases are recorded which are intended to show that respiration and circulation may be suspended for many hours, and yet the person be living. It is impossible to place any credit on narratives of this description, which generally rest upon hearsay or conjectural evidence. To suppose that the two important functions of respiration and circulation can be wholly suspended for even an hour, in a human being, without destroying life, is to set at defiance all physiological experience. Admitting the possibility of such a case occurring, it would require the best and most unequivocal evidence to support it. The phenomena of hybernation in many animals can have no reference to this condition: for in these, a final purpose is answered by the feeble state of existence into which they are thrown. While it is natural for such animals to remain torpid during the winter season, or to exist under a feeble exercise of the functions of respiration and circulation, it would be an unnatural condition for a human being and inconsistent with the maintenance of life.

There are some forms of disease affecting the nervous system, as, for example, hysteria accompanied by tetanus, or coma and catalepsy, the symptoms of which are occasionally such, as closely to simulate death. Respiration and circulation appear either to cease entirely, or to be carried on so feebly, that, to uninformed observers, the persons affected may seem to be really dead. Catalepsy, or, as it is vulgarly called, *trance*, in which the person lies in an unconscious state, may thus assume the appearance of death; but the warmth of the body is retained, the limbs are flexible, and the heart and lungs continue to act, although less vigorously than natural. (For a remarkable case of this kind, see 'Medical Times and Gazette,' 1870, 1, 495.) Cases of prolonged and profound sleep of a natural kind, which have also been described as cases of trance, cannot be mistaken for death. Dr. Cousins met with a remarkable instance which may be taken as the type of others. A man of healthy habits, forty-three years of age, was at intervals subject to attacks of long and persistent sleep. He would retire to bed at his usual hour, and, without any warning symptoms, suddenly and almost immediately fall into a profound sleep, from which all the usual means would fail to arouse him. In this state, his face and ears were pale; the skin was pale and generally warm, but his feet were cold and livid, and the limbs quite relaxed. His pulse was soft, slow, and feeble; his respirations almost imperceptible, amounting to about eight or nine in a minute. He appeared like a person in a refreshing, tranquil slumber. There was no stertor or snoring. The longest period he ever passed in profound sleep, was five days and five nights. He frequently slept three days and occasionally four days without waking, but his average period was two days. His secretions were suppressed, and no food was required. He commonly awoke suddenly, had no consciousness of the lapse of time, and retained a good remembrance of the last occurrences before he fell into this state. He had no dreams. ('Medical Times and Gazette,' April 18, 1863, p. 396.)

A similar case, from the 'Gazette Médicale,' is reported in the 'Edinburgh

Monthly Journal' for April 1845. A married woman, thirty-six years of age, became subject to attacks of prolonged sleep or trances, lasting from two to seven days, but usually about five days. They occurred suddenly without warning, sometimes during the night, and sometimes during the day. After twenty-four hours she was half roused, and her lips moistened with liquids which she swallowed insensibly, again falling asleep immediately afterwards. These trances generally occurred at intervals of from two to twenty days, during which she had no regular sleep, or, if any, it was short and disturbed. The evacuations were suspended during this state. It was found impossible to rouse her; but she awoke spontaneously, feeling much fatigued and not refreshed by this unnatural sleep. When an eyelid was lifted, the eye was found to be fixed upwards; light did not cause her pupils to contract. The respiration, circulation, and temperature of the body were in their original state, during and after these trances. ('Gazette Médicale,' January 1845; and 'Edinburgh Monthly Journal,' April 1845, p. 307.)

It has been demonstrated by Mr. Durham, that in ordinary sleep, there is a withdrawal of a due supply of blood from the capillary vessels of the brain. The remarkable fact is, that the proper supply of this fluid to the brain, should be so long withdrawn or suspended, without producing serious injury to the nervous system. This condition appears to be a kind of human hybernation. It could not be mistaken for death, even by the most ignorant observer, considering that respiration and circulation are still carried on, and the warmth of the body is retained.

Certain tests have been proposed for the purpose of ascertaining whether these processes have ceased or not. It is unnecessary to allude to them, because they appear to be wholly inadequate to the purpose intended; but in the absence of all appearance of movement in the chest and abdomen, a medical man may readily satisfy himself of the fact of respiration and circulation continuing or not, by the occasional application of a stethoscope, or of the ear itself, to different parts of the chest—especially to the region of the heart. The auscultatory test, applied at intervals during half an hour, cannot fail to lead to a satisfactory conclusion. This test, first proposed by M. Bouchut, and rewarded by the French Academy with a prize, as being the most certain method of proving death before putrefaction, has been objected to by Dr. Dowler, 1, because the heart itself may, like other muscles, be in a state of apparent, and not real death; and 2, because the pulsations and sounds of this organ may not always be appreciable to the ear, even when aided by the stethoscope. In support of these objections, it is stated that M. Brachet has repeatedly restored the vitality of new-born children, in whom no pulsation whatever could be discovered for a period of fifteen to thirty minutes after birth. In one instance a child was revived after *twenty minutes* of apparent death, by insufflation of the lungs, although during that time no pulsation could be heard or felt. Another case was that of a man, æt. thirty-three, whose heart presented no contraction that could be detected during at least eight minutes, although the ear was applied again and again. *Twenty minutes* after the suspension of its action, a slight contraction was perceived in the heart, its pulsations then became regular, and the patient opened his eyes. ('Philadelphia Medical Examiner,' Oct. 1850, p. 599.) To these may be added the case of Colonel Townshend, which carries the supposed period of the entire suspension of the heart's action to half an hour. Such cases however do not show that a person can live while the heart's action is thus continuously suspended, but that the means employed for testing the state of this organ have been imperfectly or carelessly applied.

In awarding the Manni prize, founded for the discovery of a certain sign of death, the French Commissioners, Dunéril, Andral, Magendie, Serres and

Rayer, very properly dwelt upon the state of the heart as furnishing the most unequivocal proof of death before the occurrence of cadaveric rigidity and putrefaction. M. Bouchut, to whom the prize was awarded in 1846, found, in an extensive series of researches, experimentally confirmed by the Commissioners themselves, that in all cases of apparent death, whether arising from asphyxia or syncope, there is one common character by which they may be distinguished from real death, and that is, a continuance of the pulsations of the heart. He established the fact, that in the most perfect state of syncope, attended with entire loss of motion and sensation, as well as cooling of the body, the contractions of the heart were not really at any time suspended, but simply reduced in force and frequency. In syncope from hæmorrhage, carried to the fullest extent, and in cases in which respiration was either imperceptible, or carried on at long intervals, the body at the same time having the aspect of a corpse, he was enabled by auscultation to detect the pulsations of the heart, and thus to distinguish apparent from real death. In children born in a state of apparent death, and in cases of asphyxia from any cause, in narcotic poisoning, hysterical and epileptic coma, and in all diseases which have been stated to resemble apparent death, the living has been easily distinguished from the dead body by the continuance of the heart's action—this was feeble and took place at intervals, but it was always sufficiently marked to enable a professional man to distinguish a living from a dead body.

It was considered important, if possible, to define the periods at which, after the entire cessation of the heart's action, a person might be pronounced dead. Assuming that the last audible expiration has been made, that the motions of the chest have apparently ceased, and that no pulsation can be felt in any of the arteries of the neck or limbs, the longest interval that elapsed between the pulsations of the heart was about six seconds. M. Rayer, one of the Commissioners, from his own observations on the dying, assigned as a maximum, an interval of seven seconds between the last pulsations of this organ. If, therefore, no motion of the heart is perceived during an interval of *five minutes*, a period which is fifty times as great as that which observation warrants, death may be regarded as certain. With the cessation of the pulsations of the heart, the usual cardiac sounds also cease. At the same time their cessation furnishes a proof that respiration has ceased, and that the functions of the nervous system are not merely suspended, but destroyed. ('Annales d'Hygiène,' 1848, 2, 78.)

In reference to *respiration*, the alternate motions of the chest and abdomen serve better as a means of diagnosis, and are more readily observed, than the motions of the chest alone. In the absence of a stethoscope, an opinion may be formed from an external view of the body by the following arrangement. An even piece of looking-glass, plate glass, or a basin of water or of mercury, may be placed upon the front of the chest, and the image of some object allowed to be reflected from a window, or other strong source of light. The slightest motion in the reflecting surface will be indicated by an alteration in the image of the object reflected. A well-informed practitioner can however, generally determine the question without resorting to experiments of this description.

The entire cessation of breathing, in the opinion of the late Sir B. Brodie, should be regarded alone, as a decisive test of the extinction of life. The movements of respiration cannot be overlooked by any person who does not choose to overlook them, and the heart never continues to act for more than four or five minutes after respiration has ceased. This organ has been properly described to be the *primum vivens* and the *ultimum moriens*, the first to live and the last to die. The proofs of its continued action, however,

are less obvious to the unskilled observer, than the movements of the chest; hence the visible cessation of these movements for a period of five minutes furnishes a certain proof that the person is really dead. But the skilled observer would apply the test of auscultation, and before giving an opinion would satisfy himself of the permanent cessation of the heart's action. It is impossible to admit that the heart can remain for even half an hour in a state of inaction in a human being, and then spontaneously recover its activity.

2. Coldness of the Body.—One of the most striking characteristics of life is the power which the body has, of retaining a temperature far above that of the medium in which it is ordinarily placed. Notwithstanding that the body is constantly subjected to the same laws of cooling as all other heated solids, i.e. by radiation, conduction, and convection, the supply of heat internally, is so constant and uniform, as to counterbalance exactly the loss which is experienced. Some physiologists consider that animal heat depends entirely on the chemical changes produced by respiration; but it is probable that the nervous system plays an important part in its production. ('Edinburgh Medical Journal,' vol. 58, p. 249.) When, therefore, life is extinguished, the body will gradually lose the heat which it possessed at the moment of death, just like so much inert organic matter artificially raised to the same temperature.

There is considerable discrepancy among physiologists concerning the natural temperature of the *living* body. The average temperature of the interior of the body in health varies from 98° to 100°. It is liable to be increased in some diseases and to be diminished in others. In one case of typhoid fever, M. Piorry states that he found the blood to have a temperature of 113°; and the temperature of the uterus during parturition is said to have been found still higher.

The time usually assigned for the cooling of the dead human body to the temperature of the air is from fifteen to twenty hours, but it varies according to the condition of the body at the time of death, the mode of death, and the circumstances under which it has been placed. From January to June 1863, Dr. Wilks and I collected observations on the cooling of the dead body in one hundred cases, at Guy's Hospital. The age, the cause of death, and the circumstances under which the bodies were exposed were at the same time noted. The reader will find the details of these cases in a table published in the 'Guy's Hospital Reports' for October 1863, p. 184. A summary of the observations of temperature recorded in this table leads to the following conclusions. If the periods of time be divided, first, into those which are included between two and three hours; secondly, between four and five hours; thirdly, between six and eight hours; and fourthly, twelve hours, including one or two cases extending to fourteen hours, the results were as follows:—

	First period, 2 to 3 hours	Second period, 4 to 6 hours	Third period, 6 to 8 hours	Fourth period, 12 hours
Number of observations	76	49	29	35
Maximum temperature of the body	94°	86°	80°	79°
Minimum temperature of the body	60°	62°	60°	56°
Average temperature	77°	74°	70°	69°

The temperature was tested by simply placing the exposed bulb of a thermometer on the skin of the abdomen. It should be remarked, however, that as the observations could not be commenced until the bodies were brought to the dead-house, and a variable interval elapsed, during which they remained in the ward, these temperatures are lower than they would be at the respective periods, after death; as the body would necessarily cool to some extent before the first observation could be made. They, nevertheless, show that a dead body cools slowly and progressively, and that the trunk generally retains a well-marked warmth for ten or twelve hours after death.

If the circumstances under which a body is exposed are favourable to the loss of heat, it may be found cold in eight or nine hours after death. In the case of *Millie*, for the manslaughter of whom a man named *Bolam* was tried and convicted some years since, the body, although clothed, is reported to have been found cold about nine hours after death.

It is customary to judge of the degree of coldness by the sense of touch; but the dead human skin is a good conductor of heat, and thus the surface may appear cold to a moderately warm hand. The condition of the hand itself may lead to an erroneous impression. If the two hands are of different temperatures, a recently dead body may appear cold to one and warm to the other. Another fact should also be borne in mind, that in the chest and abdomen, the viscera may retain a well-marked warmth when the surface of the skin is actually cool or cold. Among the cases observed by Dr. Wilks and myself at Guy's Hospital in 1863, it was remarked that in several a high temperature was retained by the viscera for a long period after death. In two instances a thermometer indicated in the viscera a temperature of 76° in one instance seventeen, and in the other eighteen hours after death—the temperature of the air being comparatively low (49°), and the surface of the body cool. In a third instance, ten hours after death, while the surface of the abdomen had a temperature of 65°, the interior was 85° ('Guy's Hospital Reports,' October 1863, p. 193). In all observations on the temperature of the dead body, a thermometer should, if possible, be employed. This may be applied for the exterior, either to the skin of the abdomen or to the armpits; and for determining the temperature of the interior, the bulb may be introduced into the mouth, throat, or rectum.

When death has taken place suddenly, from accident, apoplexy, or acute disease, a body has been observed to retain its heat for a long period. It is stated, by Nysten, that the bodies of persons who have died from asphyxia, by hanging, or suffocation, or from the inhalation of carbonic acid gas, do not cool, *cæteris paribus*, until from twenty-four to forty-eight hours after death; and that sometimes even *three days* have elapsed before the body has become completely cold. Too much importance must not be attached to this statement, since in some cases of fatal asphyxia, the body has been observed to cool just as rapidly as in death from other causes.

According to Dr. B. W. Richardson, a loss of blood, as in cases of death from hæmorrhage, whether the blood is effused externally or internally, or even temporarily withdrawn from the heart, as in syncope, is a cause of the rapid cooling of the body. He states that 'the decline of the temperature in these cases is so great, that the external surface of the body may actually run down to that of the air without death.' ('Medical Critic,' January 1863, p. 31.) The sudden cold of collapse observed on the surface of a living body, is here confounded with the slow and progressive cooling of a dead body. The cases which have been adduced in support of this view are exceptional instances of disease, and have no practical bearing on the question at issue—namely, the cooling of the body after the sudden death of healthy persons from wounds. Hence the conclusion drawn from them, 'if the body is left

dead from direct and absolute loss of blood, cooling to the temperature of the surrounding medium is completed, in regard to the external surface, in two hours,' may lead to a serious error, and implicate an innocent person in a charge of murder.

An opportunity of testing the accuracy of this statement presented itself at Guy's Hospital in February 1863. A healthy man, æt. forty-seven, died suddenly from hæmorrhage. A ligature had been placed on the axillary artery in consequence of an accident: this gave way, and about four pounds of blood were lost. Four hours after death I saw the body of the deceased, and found the shoulders, chest, and abdomen quite warm. The skin of the abdomen had a temperature of 84°; eight hours after death the temperature was 80°, and the arms and legs were not rigid. The conditions under which this body was exposed, were favourable to rapid cooling: it was placed in a shell with a shirt loosely over it, and the temperature of the dead-house was 38°. The alleged effect of loss of blood in accelerating the cooling of the human body when death has occurred suddenly from hæmorrhage, has therefore no foundation in fact. The only physical difference which it would be likely to create, would be by simply reducing the amount of fluids in the body to undergo the cooling process. In the above well-marked case, the loss of four pounds made no appreciable difference in the rate of cooling.

It has been suggested that coldness of the body as a result of disease, whether arising from malignant cholera, phthisis, or other chronic disease, or from death during the stage of collapse in poisoning, might create difficulty in reference to an opinion respecting the date of death. It is stated that the bodies of persons who have died of these diseases, have been found quite cold on the surface within *four* or *five* hours; at least, as cold as the bodies of healthy persons after the lapse of fifteen or twenty hours. In such cases, coldness of the body is commonly manifested before dissolution, in those parts which are the most exposed, as in the extremities of the hands and feet, the nose and ears. Like all other diagnostic signs, when taken alone, coldness of the surface is open to this objection; but the obvious cause of death, and the emaciated state of the body, as well as the facts connected with the ocurrence and disappearance of rigidity, even supposing that no history of the case could be obtained, would be sufficient to remove any doubt. The objection is of a speculative kind, and no instance has been adduced in which these morbid states have led to an erroneous medical opinion.

The physical circumstances which influence the cooling of a dead body are precisely those which influence the cooling of all heated inert substances. 1. The medium in which it is immersed. A body will cool more rapidly in water than in air—a fact which may be important in a question of survivorship in drowning; and it will cool more rapidly in the open air than in a dwelling—on the floor than in bed, or under exposure to a current of air than in a warm, tranquil atmosphere. It will cool more rapidly in a large apartment than in one which is small. The dead human body cools, first, by radiation; secondly, by conduction; thirdly, if naked and exposed, by convection: consequently, its own mass, as well as the nature of the materials with which it is in contact, must modify the results. The body of an adult, *cœteris paribus*, cools more slowly than that of a child, or of an old person; and that of a fat or corpulent person cools with less rapidity than one which is lean and emaciated. Again, when the dead human body is placed on good conducting substances, or is exposed to the open air in a naked state, the cooling process will be hastened. If, on the contrary, it is much covered with badly conducting materials, as cloth, flannel, or cotton, and is allowed to remain on a bed, it will require more than the usual period of time to become cold.

The dead body, like so much inert matter, continues to cool until it reaches

the temperature of the medium (air or water) to which it is exposed. As the soft solids are not good conductors of heat, the inner parts of the body are much longer than the surface in acquiring the temperature of the surrounding air; and, for the same reason, when once cooled, it is long before they reach the temperature of the air, supposing this to have risen. Thus, if a dead body is cooled to 60°, and the air in the room suddenly increases in temperature to 80°, the viscera may be found to remain for some time at 60°. The dead body is not, therefore, like a minimum thermometer in marking a low temperature, but, like all dead flesh, its temperature rises and falls with the thermometer, although more slowly than other solids possessing better conducting powers.

Mere coldness of the body is not incompatible with a continuance of life; for many morbid causes may modify, or even altogether suspend the production of heat in the living subject. Thus, in syncope or hysteria, it is not unusual to meet with extreme coldness of the skin; but this differs from the coldness of death, in taking place over the whole body *suddenly*, and in even preceding the state of apparent lifelessness. It does not depend merely, as in death, on the slow and gradual loss of heat, because it is perceptible even when the body is placed in conditions under which a heated substance would not become cold. Besides, the interior of the body at the rectum or throat will be found to have a higher temperature than the skin of the chest or abdomen. Let us take the opposite condition—Can the warmth of the human body be retained in its normal state for any length of time after death? We might suppose, *à priori*, that this question should be at once answered in the negative; but there are numerous authentic observations which show that heat may be sometimes long retained by the dead body, both on the surface as well as in the cavities; and it has been noticed, in certain fatal diseases, that the temperature has actually risen in the body after death. This exceptional retention of heat has given rise to the erroneous suspicion that the person was still living, as in the following case, a report of which appeared in the 'Lancet' some years since:—

A servant girl, who had retired to bed in apparently perfect health, was found on the following morning, as it was supposed, dead. A surgeon who was called in pronounced her to be certainly dead, and stated that she had probably been dead for some hours. A coroner's inquest was summoned for four o'clock of the same day, to inquire into the cause of death; and directions were given that a post-mortem inspection of the body should be made in the meantime. The reporter of the case was requested to give his assistance. Accompanied by the surgeon who had been consulted, he went to the house about two o'clock, for the purpose of making an inspection. The deceased was found lying on the bed, in an easy posture, on her left side, her body forming somewhat of a semicircle. The countenance was pallid, but so perfectly placid and composed, as to give to her the appearance of being in a deep sleep. The heat of the body, although she must have been dead eight or ten hours, was not in the least diminished. The room was carefully searched, but nothing in the shape of poison, nor any other means of self-destruction, could be discovered: every article of apparel lay around, as it might be supposed to have been left, by a person going to bed in perfect health as usual. The heat of the body not diminishing, a vein was opened, and various stimuli applied, but without producing any sign of resuscitation. Respiration and circulation had ceased; no artery could be felt pulsating in any part. Two hours had now elapsed since their arrival, and the parties still hesitated to perform the inspection, when a message was sent to them, stating that the jury were waiting for their evidence. The inspection was then commenced; but in moving the body for the purpose, the warmth and

pliancy of the limbs were such as to suggest to the examiners that they were inspecting a living subject! The internal cavities were so warm that a copious steam issued from them when they were laid open. All the viscera were healthy, there were no signs of disease;—nothing appeared to account for death, and from what they saw, the inspectors regretted that they had not postponed the examination until the signs of death had been more completely manifested! For obvious reasons, the name of the place where this extraordinary case occurred, and the name of the reporter, were suppressed. It is probable that a high temperature was retained by this body for a much longer period than usual after death. There were, however, two physical causes in operation, the influence of which does not seem to have been sufficiently appreciated. The girl died suddenly while in a state of perfect health and vigour; and until the time of inspection, the body appears to have remained in bed closely covered by badly-conducting materials; *i.e.* the bedclothes. The temperature of the room in which the body was found, is not stated; but as the month was October, it was probably not low. The temperature of the surface or of the internal organs, was not determined by a thermometer. Although there can be no doubt that this girl was really dead, yet, as a rule, no medical man is justified in making an inspection of a body until after the signs of death (coldness and rigidity) have been clearly manifested. Respiration and circulation had ceased, and no pulsation could be felt in the heart or arteries; the body had been in this state for at least eight hours; hence it is evident that this was not a case of apparent death. The examiners were simply deceived by an unusual retention of heat in the viscera. Doubts were entertained for several days respecting the death of the well-known Professor Dieffenbach, of Berlin. The unusual retention of heat, and the delay of the putrefactive process, led to the supposition that he was only in a state of apparent death.

It can scarcely be imagined that the production of heat should continue in a really dead body; and yet certain facts connected with the malignant cholera, yellow fever, and other diseases, appear to establish the possibility of this. In some cases of death from malignant cholera, when epidemic in this country, in 1832–3, the body, which had become moderately cold, was observed suddenly to resume its warmth, so that the temperature is stated to have risen some time after death as high as 87°, although circulation and respiration had entirely ceased. In another instance the temperature was observed to rise from 79° to 92° after death. This singular phenomenon, like numerous others connected with that disease, has received no adequate explanation. According to Valentin the occurrence of post-mortem heat is common to all dead bodies, the difference being only in degree. It is said to be most rapidly developed after death from injuries to the nervous centres, especially the brain. In cerebro-spinal meningitis the temperature has risen after death from 104° to 111° Fahrenheit, and in a fatal case of small-pox, attended with much delirium, Simon observed that the thermometer rose at death from 104° to 113° ('Lancet,' 1870, 1, 21). This production of heat after the cessation of breathing, must be taken as positive evidence of some latent vital power or chemical force still lingering, about the circulating system; for in real death, the animal body, when it has once become cold, is no more capable of spontaneously generating heat within itself, than any of the inert and lifeless solids by which it is surrounded.

In a case of death from Asiatic cholera, Mr. Rumsey observed that half an hour after the complete cessation of respiration and circulation, the muscles of the arms underwent spontaneously various motions of contraction and relaxation, continuing for upwards of an hour, and that although previously cold, they then became evidently warmer. The restoration of warmth after

the body has become cold in such cases, can only be explained by supposing that there still remains about it some lingering trace of vital action; although this may not be indicated by the presence of the ordinary signs of active life. The facts connected with the production of heat in the dead body, have not received much attention from physiologists.

Dr. John Davy met with some very high temperatures in the *dead* body. In a case of rheumatism, after the viscera had been exposed for nearly ten minutes, the mercury of a thermometer, placed under the left ventricle, rose to 113°, and when in contact with the lobulus Spigelii of the liver to 112°. In a second subject, examined *six hours* after death, the thermometer under the left ventricle indicated a temperature of 108°, and when in contact with the lobulus Spigelii 107°. In these cases, the patients were ill but a short time, and died suddenly; and the temperature of the apartment in which the observations were made, was 86°. This increase of temperature after death has been referred to putrefaction; but Dr. Dowler has shown that it takes place soon after death, and before rigidity sets in. Some of the cases reported by Dr. Wilks and myself also show that it may take place independently of putrefaction. ('Guy's Hosp. Rep.' Oct. 1863, cases 4, 26, 30, p. 184.) Dr. Dowler has called this condition post-mortem caloricity; he has noticed it as a common occurrence, in a warm climate, in the bodies of persons who have died from yellow fever. The heat of the body, according to him, continues to increase for several hours after death; and in one case, after six hours, he found the arm-pit to have a temperature of 100°, and the abdomen, of 103°. In another, the temperature of the arm-pit during life being 100°, it was found that in three hours after death, the temperature of this part had risen to 104°; in a third case, a similar increase was observed in thirty minutes. The highest post-mortem temperatures were observed in the thighs. Thus in a case in which the arm-pit had, during life, a temperature of 104°; in ten minutes after death it indicated a temperature of 109°, and in fifteen minutes after death, the thigh gave a temperature of 113°. When the maximum, which is variable in different bodies, has been attained, the body gradually undergoes the cooling process observed after death, and according to Dr. Dowler, this generally commences with the head. ('Phil. Med. Examiner,' Oct. and Nov. 1845, pp. 625 and 359.) In death from malignant cholera, he found that the dead body reached its maximum temperature of 109° in about an hour and a half. Dr. Hensley has published, in the same journal, a series of cases in old and young persons, who had died from different causes; these do not show a similar increase of heat, but they prove that after thirty hours, a dead body may retain a temperature two or three degrees above that of the room (March 1846, p. 151). These observations may serve to explain facts similar to those observed in the case of supposed premature inspection just now related, for they show that in some exceptional instances, a really dead body may retain for many hours a temperature as high, or higher, than that which is usually found in the living.

Dr. Dowler considers that the gradual loss of heat in the *interior* of the body, as determined by a thermometer, furnishes the best test to establish the reality of death. The living body maintains a uniform temperature, independently of that of the surrounding medium; but a dead body, like other inert matter, is governed in its temperature by purely physical conditions, 'heating and being heated, receiving and radiating caloric. This is not the result of speculation, but of prolonged and varied experimental research.' ('Phil. Med. Examiner,' Oct. 1850, p. 606.) It may be observed, however, that in temperate climates, the signs of death are sufficiently well marked by the progressive cooling and rigidity of the body, before the application of the thermometrical test to the interior could be made; hence, although it

would furnish information that death had certainly taken place, a medical examiner could come to a safe conclusion without it. The occasional existence of post-mortem heat offers no objection to this conclusion, since cooling sooner or later follows this condition, as a result of ordinary physical causes. The coldness of the living body in cholera, congelation, hysteria, &c., is a physiological condition, and not the result of physical cooling. If death takes place, the coldness may continue, or the body may again become warm. In either case it passes ultimately, by physical cooling, to the temperature of the surrounding medium.

3. Cadaveric Rigidity. Rigor Mortis.—In from five to six hours after death and generally while the body is in the act of cooling, the muscles of the limbs are observed to become hard and contracted, the joints stiff, and the body firm and unyielding. This peculiar condition is known under the name of cadaveric rigidity. The first effect of death from any cause is in most cases a general relaxation of the whole of the muscular system. The lower jaw drops, the eyelids lose their tension, the limbs are soft and flabby, and the joints are quite flexible. The muscular tissue may be considered as passing through three stages in a dead body. 1. It is, as above mentioned, flaccid but contractile, although, as it will be seen hereafter, muscles contracted by living force in the act of dying, do not necessarily become relaxed in death; 2. It becomes rigid and incapable of contraction; and 3. It is once more relaxed, and does not regain its power of contractility. The body now passes into the incipient stage of putrefaction. The first stage defines the duration of muscular irritability; the second stage, that of cadaveric rigidity; and the third, that of the commencement of chemical change or putrefaction.

Its Seat.—Experiment shows that the seat of this phenomenon is in the muscular system, for the rigidity disappears immediately on the removal or division of the muscles. According to the experiments of Béclard and others, the rigid condition of the muscles is wholly independent of the integrity of the nervous system: for a division of the nerves leading to the particular muscles, or even the entire removal of the brain, has not been found to prevent it, or to retard its occurrence. It has also been observed, that when death has taken place from paralysis, hemiplegia, or apoplexy, the rigidity has been as strongly manifested by the muscles of the paralytic or hemiplegic, as by those on the healthy side, provided they are well nourished and retain some irritability. The muscles of shattered limbs in death from comminuted fractures, do not take on this condition. It is probable that the rigidity is due to a vital action in the muscular fibre; and possibly, as John Hunter imagined, it may be the last effect of the vital force on the muscular system. According to Kussmaul the living metamorphosis of the muscle has ceased; the muscle becoming rigid is a dying—the perfectly rigid, is a dead muscle. Rigidity is in general observed to take place simultaneously with the coagulation of the blood throughout the body. Some have considered it to depend upon this: but not to mention that the alleged cause appears to be wholly inadequate to the effect produced, the rigidity sometimes occurs while the body is warm and the blood fluid, therefore this cannot be the true explanation: moreover it closely resembles the rigidity of syncope and asphyxia, which can have no reference to the coagulation of the blood.

M. Brown Séquard found by experiments on rabbits that if a current of arterial blood is re-established through muscles in which cadaveric rigidity has already begun to show itself, they cease to be rigid, and recover their irritability. He even succeeded in removing the cadaveric rigidity from the muscles of the decapitated body of a criminal, thirteen hours after execution and two hours after the supervention of rigidity, by the injection of defibri-

nated human blood. The muscles lost their rigidity, and continued to contract on irritation for several hours. ('Gaz. Méd. de Paris,' Nos. 24 and 27; and 'Amer. Journ. Med. Sci.' Jan. 1852, p. 221.) These facts appear to show that the muscles on becoming rigid, still possess a vital power. Rigidity is undoubtedly referable to the spontaneous contraction or rather stiffening of the muscles; until it appears, these organs are susceptible of galvanic and mechanical stimuli, but after it has ceased, this irritability of the muscular fibre is entirely lost. The power with which these organs contract in a state of rigidity is far less than that observed, when they are subjected to the influence of volition in the living body. The contractile force is not so great as to induce any apparent alteration in the position of the parts to which the tendinous extremities of the muscles are attached;—so that there is no displacement, nor is any force of a counterbalancing nature, manifested between flexors and extensors. It is asserted that the flexor muscles are usually more contracted than the extensors, so that the limbs and trunk, as well as the fingers, if left undisturbed in the dead body, have a tendency to assume a state of flexion. As a general rule, however, the position in which the muscles may be, at the time of death, is that which they retain during the state of rigidity, whether the body be lying, sitting, or standing, and whether the limbs be in a state of flexion or extension. When the rigid state is strongly manifested, the muscles assume a prominence, as under violent contraction in the living body.

The *time* at which rigidity occurs after death, as well as its duration, is affected by various circumstances. It generally commences within *five* or *six* hours, and lasts from sixteen to twenty-four hours. Sommer assigns the time at which it occurs, after the cessation of respiration, as not later than seven hours. Nysten, who closely investigated this subject, considered that rigidity never made its appearance in the muscles, until the body had entirely lost its animal heat; but some of his own observations tend to show that this statement is not correct. Cases every now and then present themselves, in which after death, the limbs become rigid while they are yet warm; and it is the same with the trunk.

Ollivier observed, in cases of death from malignant cholera, that cadaveric rigidity occurred while the body was yet warm. He has also seen a rigid condition of the muscles in well-developed bodies, which were inspected in from six to eight hours after death. ('Ann. d'Hyg.' 1833, 1, 233.) M. Brown Séquard mentions the case of a man who died in one of the Parisian hospitals in 1849, in whose body cadaveric rigidity appeared three minutes after he had ceased to breathe, and while the heart was still beating twenty times in a minute, while the man was still alive, if life is considered to persist so long as the heart beats! These beatings ceased only three minutes and a half after cadaveric rigidity had shown itself everywhere. A quarter of an hour afterwards, there was no trace of cadaveric rigidity, and in less than an hour after death, signs of putrefaction had appeared in the limbs. This man died of exhaustion after prolonged typhoid fever. ('Savory on Life and Death,' p. 196.) According to Küssmaul, when the muscular system is powerfully developed and death is sudden, rigidity may not occur for sixteen or seventeen hours, and the shortest period within which it may occur and pass off in such cases, is about ten hours after death; but under certain circumstances it may continue for fourteen days or even longer. In a case in which I was consulted, a stout muscular man died suddenly from an attack of apoplexy. His body was exhumed and examined three weeks after death in the month of January. It was in a good state of preservation, and the limbs were so rigid that it required a great degree of force to bend them. No doubt in this case the cold favoured the continuance of rigidity.

The following case related by Dr. Chowne, shows the rapid access of cadaveric rigidity in a new-born child, as well as its occurrence in a dead body before the entire loss of animal heat. This gentleman was called to a labour, and when he arrived, the child had been born about three quarters of an hour, and the midwife was then engaged in dressing it. One arm was a little raised and the hands were partly closed—these circumstances giving it the appearance of being a living child. He found, however, that it had actually been still-born, and that it had been part of the time in a warm bath. The other limbs were also stiff in about the same degree. The stiffness was unequivocal, there was no elasticity, as if it was the result of spasmodic muscular contraction :—a joint being flexed, it remained flexed. The midwife particularly observed the stiffness while the child was in the warm bath. The mother said the child moved, very perceptibly to herself, not long before its birth. Whether the skin was hot or cold is not stated, but the body of a child cools very quickly. It is probable from the midwife's statement, that the rigidity came on immediately or very soon after death. Sommer placed the bodies of two infants, which had died asphyxiated, in tepid baths at from 90° to 99° immediately after birth, and left them there. In between three and four hours rigidity was developed, and had attained its height in six hours. In eleven hours the rigidity of the lower jaw had disappeared. The presence of *rigor mortis* in a new-born child may show that it has been recently living, but it will not show that it was born alive. In a recent case of alleged child murder, tried at the Dorchester Assizes, the rigidity of the body of the infant was wrongly assumed to indicate that the child had been born alive, and had had an independent existence. Mr. P. C. Parkinson of Wimborne, has communicated to me the following case (1871). He delivered a woman of a child which died during labour. On the next day the fingers of the dead child were tightly clenched, the fore-arms rigidly bent on the arms and the legs on the thighs. In another case he was compelled to perform craniotomy on a dead child to effect its delivery. On the following day there was strong *rigor mortis*.

I observed in a cat which had died from disease, that the body and limbs became perfectly rigid about an hour after death, while warmth was still very great throughout. The bodies of birds generally become rigid before they cool. I have also remarked, in animals poisoned by prussic acid, where convulsions ensued, that they died in violent muscular spasm, with the limbs and tail perfectly rigid while the body was warm. This last condition, however, corresponds rather to what has been called cadaveric spasm than cadaveric rigidity. The difference between these two states will be a subject for after-consideration.

Cæteris paribus, rigidity is always more strongly manifested and continues for a longer period, in those bodies in which the muscular system is healthy and fully developed. It has been observed, that the time at which it appears after death in muscular subjects, is longer than in other cases, so that it may not supervene for twelve or fourteen hours, and it may last for twenty-four, or thirty-six hours. Rigidity is said to be slow in manifesting itself in death from hæmorrhage, irritant poisoning, apoplexy, wounds of the heart, decapitation, as also in all cases of asphyxia, especially in death from hanging, or from the action of carbonic acid. In a remarkable case of suicide from a fatal wound in the throat, observed by Dr. Handyside, the rigidity of the muscular system commenced while the body was yet warm, and was complete in *one hour and a half* after death. This early occurrence of rigidity cannot be referred to any influence produced on the muscular system by loss of blood. In a case of death from hæmorrhage, in which four pounds of blood were suddenly lost from the axillary artery, it was observed that eight hours

after death, the arms and legs were pliant; and it was not until twelve hours after death, when the body was becoming cold, that rigidity manifested itself. Death by hæmorrhage, therefore, does not accelerate this condition; it appears to have no more influence upon the period of its occurrence, than it has upon the cooling of the body. So with regard to irritant poisoning in an acute form; no difference was observed in reference to the rate of cooling or the commencement of rigidity in a well-marked case of death from arsenic in eleven hours. In a case of suffocation by charcoal vapour, Nysten observed that rigidity did not make its appearance until *sixteen* hours after death, and it is stated to have lasted for the long period of *seven* days. In other instances of suffocation, this protraction of cadaveric rigidity has not been noticed.

In these cases, the slow access of this state depends less on the mode of death than on the irritability of the muscles at the time of death. This is always great when the nutrition of the muscles is perfect, a condition which exists in cases of violent death, as from decapitation, sudden hæmorrhage, or some form of asphyxia. Dr. Symonds has seen a body in a state of rigidity eight days after death by hanging. Nysten found that there was muscular irritability in the body of a decapitated man, twenty-six hours after the head had been severed from the body; and Brown Séquard states as the general result of his experience, that in the bodies of healthy persons decapitated or asphyxiated, cadaveric rigidity did not appear sooner than ten or twelve hours after death, and that it lasted more than a week even when the weather was warm. He has found in the muscles of the limbs of two decapitated men, some degree of irritability thirteen and fourteen hours after death.

Atmospheric changes appear to modify considerably the duration of this state. Dry and cold air will cause it to persist for a long time; and thus it is, that during the winter season, especially in a frost, it is slow in disappearing;—its mean duration being then from twenty-four to thirty-six hours. If the air is warm and saturated with humidity, it soon ceases. Temperature appears therefore chiefly to affect its duration and intensity. Sommer found that, other things being equal, bodies became rigid as quickly in an atmosphere of from 59° to 63° as in one from 77° to 81°; but that the bodies of strong persons continued rigid for eight or ten days at a temperature of from 36° to 45°, while it totally disappeared in from four to six days when they were exposed to a temperature of from 65° to 86°. Bodies sunk in cold water soon pass into this state, and retain their rigidity for a long time. Water is a better conductor of heat than air, and tends to retard putrefaction. The contracted state of the skin known as *cutis anserina* is sometimes observed in a recently-drowned body.

According to Nysten cadaveric rigidity first appears in the muscles of the trunk and neck; it then takes place in the muscles of the upper extremities, and lastly in those of the lower. In regard to its disappearance, the muscles of the lower extremities will often be found rigid, while those of the trunk and upper extremities are again in a state of relaxation. It appears later and lasts longer in the lower extremities, than in other parts of the body. If Nysten's theory were true, that rigidity depended exclusively on the mere loss of heat, it should appear first in the lower extremities, and last in the trunk. His own observations, therefore, respecting the order of its disappearance are against his theory. Later observers have to some extent corroborated Nysten's statements regarding the commencement and diffusion of rigidity. Thus it begins almost always in the neck and lower jaw. Sommer found only one exception to this rule in examining two hundred dead bodies. From the neck it passes in two directions: upwards to the muscles of the face, and downwards to the muscles of the upper extremities and trunk—then attacking those of

the lower extremities. In the particular limbs, it commonly proceeds from above downwards, and it generally passes off in the same order. It always sets in, increases, and decreases imperceptibly and gradually, in which respect it differs strikingly from the rigidity of muscles as a result of disease. ('Küssmaul, Vierteljahrsschrift für die praktische Heilkunde, 1856,' B. 2, s. 67. See also a translation by Dr. Moore, 'Dublin Quar. Jour. Med. Sci.' 1856, vol. 22, p. 490.) A more recent observer, M. Larcher, who states that he has examined more than six hundred dead human bodies, as well as the bodies of a great number of animals, assigns the following course unless convulsions may have been present at the time of death. Rigidity commences in the lower jaw—affects the lower limbs—and afterwards the neck and the upper limbs. Those muscles which are the first to become rigid are the longest to retain rigidity. ('Ann. d'Hyg.' 1869, 1, 469.)

It will now be necessary to consider whether a living body ever assumes a condition analogous to that of cadaveric rigidity. Tetanus, apoplexy, catalepsy, hysteria, syncope, and asphyxia, have been stated to present symptoms which might lead to doubt respecting the reality of death from this sign. There are, however, these striking differences. In rigidity from any of these diseases, the warmth of the body is commonly in great part preserved, if not on the surface, in the rectum and flexures of the joints. The rigidity of disease takes place simultaneously with the apparent suspension of life from the attack; and lastly, the whole of the body becomes equally rigid at the same moment, owing to the existence of a universal muscular spasm. In order to distinguish this state of spasm in a really living member from the rigidity of death, it has been recommended to bend it forcibly; if it be in a state of spasm from disease (tetanus), it will return to its original position so soon as the bending force is removed; if it be in a state of cadaveric rigidity, the limb will not return to its position, but may be afterwards moved in any direction. If rigidity was at the time fully developed, the muscle will not again become rigid; if, however, rigidity was only commencing, then the limb will again resume its rigid condition, but slowly. (Sommer.) This is the main distinction between rigidity in a living and in a dead body. In real death, however, other unequivocal signs will be present. Rigidity takes places in the muscles of the countenance as well as in those of the body. It is important to bear this in mind, since identity may be mistaken when a corpse is seen about this period. The expression of the countenance, as of anger, pain, or terror, at the moment of death, depends on the contraction of the facial muscles. After death these, like other voluntary muscles, undergo relaxation, and the face assumes a placid appearance; but as rigidity manifests itself, there is sometimes a remarkable change of expression. The face is pale or sallow, the jaws are fixed, the corners of the mouth are drawn downwards, the temples sunk in, and the brow contracted. Even those who may have known a person well during life, would scarcely recognise him at this time, were they to see the body in a strange locality. Dr. Snow was once called to see a young woman after she had been dead three days, whose face had suddenly become so suffused and red, that her friends doubted the reality of her death. After a time, however, the colour abated, and the commencement of putrefaction clearly proved that she was dead. ('Medical Critic,' January 1863, p. 26.) I have witnessed a similar appearance in a corpse; the cheeks acquired a florid red colour between the third and fourth day after death, when rigidity had ceased. It is supposed that this colour is due to the action of the oxygen of the air on the blood forced into the capillaries by incipient decomposition. It is hardly necessary to observe that this appearance, coupled, as it is stated to have been in some cases, with a slight degree of warmth, could not give rise

to any mistake about the date of death, since the rest of the body would be cold, and in death which is really recent, the face becomes cold before the skin of the chest and abdomen.

According to Dr. Symonds, the kind of death always has a great influence on the expression of the countenance. On fields of battle, the corpses of those who have died of stabs are easily distinguished by the countenance from those who have fallen by gunshot. In the former, an extremely painful impression must have been transmitted to the brain, which produced the usual change in the nerves and muscles of expression; in the latter, concussion was given to the whole system, paralysing, without any intermediate sensation, so that no expression remained more than that of the repose of the muscles. ('Cyc. Anat. and Physiol.' art. Death.)

The involuntary muscles are subject to cadaveric rigidity as well as the voluntary, and by reason of the more speedy loss of muscular irritability, it appears in them more rapidly. The ventricles of the heart commonly lose their irritability within an hour after death. They become rigid, and remain in that state for ten or twelve hours, sometimes for twenty-four or thirty-six hours, then again becoming relaxed or flaccid (Carpenter). Duval saw the heart of a criminal a quarter of an hour after decapitation, beating with great distinctness. The left auricle in particular exhibited strong and regular action, forty-four times in a minute, and continued to do so for an hour. ('Prov. Med. Journ.,' September 1851.) At a certain period after death, the heart becomes rigid and firmly contracted. If examined at this time, it may appear to be in a state of spasm and to have its walls thickened, while the cavity of the left ventricle may be described as being much smaller than in the normal state. Sir James Paget has pointed out that this natural condition of the heart after death has led to pathological mistakes, the walls being described as thickened and the cavities being diminished in size, and the heart itself as being in a state of concentric hypertrophy from disease. On the other hand, the perfect relaxation of the heart which follows at a latter period after death, has been mistaken for and described as a morbid flabbiness and flaccidity. Spasm and paralysis cannot be inferred to have existed when we discover these conditions of the heart in the dead body.

The observations of M. Brown Séquard have furnished an explanation of many of the difficulties connected with the occurrence, duration, and disappearance of cadaveric rigidity. ('On the Relations between Muscular Irritability, Cadaveric Rigidity, and Putrefaction,' 'Proc. R. S.' May 1861, p. 204.) This physiologist agrees with Nysten and others that the greater the degree of muscular irritability at the time of death, the later cadaveric rigidity sets in, and the longer it lasts; and the later also putrefaction appears, and the more slowly it progresses. Müller and Gierlichs had already shown that rigidity does not occur until the muscles have lost their irritability, or their power of contracting on the application of ordinary stimuli; that in frogs, in which, as in other reptiles, muscular irritability is very persistent, rigidity is often not established until three or four days after death; that in birds, on the other hand, in which muscular irritability remains but a short time after death, rigidity ensues quickly. Further, all circumstances which cause a speedy exhaustion of muscular irritability during life, induce an early occurrence of cadaveric rigidity, while those conditions by which the appearance of irritability is delayed, retard its access. ('Baly and Kirke's Physiology,' 1848, p. 9.) M. Brown Séquard observed as a result of his experiments on animals, that when the temperature of the muscles was diminished before death, their irritability lasted long after death; cadaveric rigidity set in late, and lasted long; and putrefaction appeared late and proceeded slowly. Whatever exhausts muscular irritability, such as violent exercise or exertion,

accelerates rigidity in the dead, and, in an equal degree, putrefaction: this applies to observations on man, as well as on animals. Rigidity takes place rapidly in the dead bodies of cattle that have been overdriven, or of animals that have been hunted to death. Dr. Mackintosh of Downham has communicated to me some facts which he has collected respecting the bodies of hares run down by coursing. Cadaveric rigidity generally appeared in from one hour to one hour and a half—but the longer and the more severe the course, the sooner it appeared—thus bearing out the views of Brown Séquard respecting the exhaustion of muscular force. In three of these experiments, the throats of the animals were cut when they were run down. One lost two ounces of blood, a second lost very little, and a third none. Yet in each of these instances cadaveric rigidity began one hour and twenty minutes after death. The bodies of soldiers killed in the early part of a battle become rigid slowly, while the bodies of those who are killed at the close, after many hours of violent muscular exertion, become rigid almost immediately. This may explain the singular fact recorded by military men, that the dead bodies are sometimes found on the field of battle stiffened in the attitude of kneeling or sitting, with their weapons clenched firmly in their hands. There has been no relaxation in death, but the muscles appear to have at once passed from a living contraction into a rigid condition. This also throws light upon a fact to be presently noticed, that suicides are sometimes found with weapons grasped in their hands, and their bodies stiffened in the attitudes in which they have died. It may be inferred in these cases that from some cause operating during life, the muscular irritability was exhausted at the time of death. Hence the greatest differences are observed to exist in regard to the commencement of cadaveric rigidity and putrefaction, in consequence of the variable degree of muscular irritability at the time of death. Dr. Brinton, U.S., has recorded his experience on this curious subject during the American war. In many who had died instantaneously from brain and heart-wounds, the body was rigid throughout, and the position was that of the last moment of life. He has called this *instantaneous rigor*. After the battle of Antietam in 1862, he counted within a small space forty dead bodies, mostly with chest wounds. There were some with their arms raised rigidly in the air, and others with their legs drawn up and fixed. In not a few the body was curved forwards and fixed. These attitudes were not those of the relaxation of death, but were rather of a seemingly active character, the muscles remaining rigid and inflexible as the result of spasmodic muscular action in the last moment of life. ('Amer. Jour. Med. Sci.,' Jan. 1870, p. 87. Also 'Lancet,' 1870, 1, 276.)

The effects of strychnia and other poisons which produce convulsions may be explained by reference to their action on the muscles. Rigidity has been observed to set in with great rapidity in animals destroyed by strychnia or veratria. Küsmaull made a similar observation in reference to the action of coal-gas on the system. Brown Séquard noticed that when death was produced almost at once by these poisons, or by others having a similar mode of action, *e.g.* atropia, morphia, oxalic acid, and cyanide of mercury, there was hardly any effect observed on the time of access and duration of rigidity and putrefaction; but when convulsions had existed for a long time before death, the influence was most remarkable. He poisoned three healthy dogs, as much alike as possible, with the acetate of strychnia. One of them had a dose of two grains, another of half a grain, and the third of one-fourth of a grain. The first dog died at once; the second after twelve minutes, during seven of which it had convulsions; and the third after twenty-one minutes, during eleven of which it suffered from convulsions. The following are the tabulated

results in reference to the duration of muscular irritability and of cadaveric rigidity, as well as of the occurrence of putrefaction:—

	Durat. of musc. irrit.	Durat. of cad. rigid.	Putrefaction.
1st dog . . .	8 hours . . .	19 or 20 days . . .	slow
2nd dog . . .	$2\frac{1}{2}$ " . . .	5 days . . .	rapid
3rd dog . . .	$\frac{1}{2}$ " . . .	less than a day . .	very rapid

In other animals which were killed by poisons causing convulsions, the more violent and frequent the convulsions were, the sooner cadaveric rigidity set in after death; and the shorter the time that it lasted, the sooner also did putrefaction appear, and the more rapid its progress. In reference to my own experiments, a rabbit died from the effects of half a grain of strychnia in twenty-three minutes; during the last eleven minutes it had several fits of convulsions, and died in one of these. In ten minutes after death, rigidity showed itself in the hind legs, and rapidly spread throughout the body. The rigidity had decreased in two days, and had nearly disappeared in four days. ('Guy's Hosp. Reports,' October 1856, p. 112.) Mr. W. Clegg, of Boston, has communicated to me the case of a woman who died in September 1864, from the effects of a large dose of strychnia, whose body passed rapidly into a rigid state. The strychnia, mixed with laudanum, was taken about 8.30 A.M., and she was found dead in a field, with the limbs rigid and the body quite cold, at 11 A.M. There was slight warmth in the arm-pits. The deceased was fully dressed, and the weather was warm for the time of year. In the body of a strongly-built woman, who died of hydrophobia after violent convulsions, Brown Séquard found that cadaveric rigidity had set in within the first hour after death, and that it had ceased before the end of the tenth hour.

Although, according to Nysten, the later the time at which rigidity commences the longer it lasts, yet it does not necessarily follow that when it speedily supervenes after death, it will rapidly disappear. There are many facts which show that when the muscles are strongly contracted at the time of death, they become rigid in this contracted state, and remain rigid for many hours, and even days.

The rigidity produced as a result of poisoning by strychnia may sometimes continue for a very long period. Thus, in the case of *J. P. Cook* (*Reg.* v. *Palmer*, 1856), the body, when examined on the sixth day after death, was in a state of rigid spasm, and the members were found in a similar state on the exhumation of the body two months afterwards. It is worthy of remark that Cook lived only twenty minutes after the symptoms first appeared. He suffered from a few convulsive fits, but not sufficient to exhaust the irritability of the muscular system.

These facts have an important bearing on cases of poisoning by strychnia and other spinal poisons. The state of the dead body will vary according to the rapidity of death, and the degree of exhaustion of muscular irritablity at the time of death, as a result of the fits of convulsion produced by the poison. They also show that when, from whatever cause, muscular irritability at the time of death is slight, either in consequence of a bad state of nutrition or of exhaustion from over-exertion, or from convulsions caused by disease or poison, cadaveric rigidity sets in and ceases soon, and putrefaction appears and progresses quickly. (Brown Séquard, 'Proc. R. S.,' May 1861.) For a similar reason it takes place at an earlier period in the very young and the old, than in an adult at the prime of life.

It has been long observed that the bodies of those who are emaciated, or who die from debilitating diseases, such as phthisis, typhus or typhoid fever, and malignant cholera, pass rapidly into a state of rigidity, which is commonly of short duration. Hence, owing to want of correct observation, it has been

erroneously stated that cadaveric rigidity did not occur in such cases. In reference to deaths from malignant cholera, Brown Séquard observed, that cadaveric rigidity appeared late and lasted long in those patients who died quickly, that is, before a prolonged alteration of nutrition, and that those muscles which had been attacked with violent and frequent cramps, became rigid very soon after death, and remained so only for a short time. M. Ollivier found that the bodies of cholera patients were frequently rigid in from six to eight hours after death, while the muscles which were the seat of this rigidity were still warm, and on making an incision into them, the blood readily flowed out. A similar error has arisen respecting the bodies of persons killed by lightning. John Hunter thought that cadaveric rigidity did not occur in this mode of violent death; but the late Sir B. Brodie found that the body of an animal killed by electricity became, as usual, rigid after death. In an accident which occurred in France, in August 1846, a group of labourers was struck by the electric fluid: four were killed on the spot, and five or six severely wounded. It was remarked that the person whose body bore the most extensive marks of injury had worn a goat-skin. There were several lacerations about this body, and in three hours after death it became perfectly rigid. ('Med. Gaz.,' vol. 38, p. 351.) In a case of death from lightning, communicated to the 'Medical Gazette,' by Dr. F. J. Brown, rigidity was strongly marked in the limbs about twenty-eight hours after death (vol. 47, p. 844). In May 1854, during a storm, a man was struck by the electric fluid. He made a short exclamation, and immediately expired. It was observed in this case that the body became rigid after death.

Facts are now sufficiently numerous to enable us to say that the old opinion of the non-occurrence of rigidity in the bodies of persons killed by lightning is unfounded. Dr. Bagot, of Ballingarry, has informed me that, in a case which he examined in the summer of 1855, the body of a man, æt. 28, who had been killed by lightning, was as rigid twenty-eight hours after death as if death had taken place from any other cause. The researches of Brown Séquard afford a satisfactory explanation of the differences among physiologists upon this question. In some instances, no doubt, cadaveric rigidity has set in, and has been of such short duration, that it has not been possible to ascertain its existence. Death by lightning may be the result, 1st, of syncope by fright, or in consequence of a direct or reflex influence of lightning on the par vagum; 2ndly, of hæmorrhage or bleeding in or around the brain, the lungs, or pericardium; and 3rdly, of concussion, or some other change produced by the electric fluid on the brain and nervous system. When death by lightning is due to any one of these causes, cadaveric rigidity may appear and run through its course rapidly, as in some other cases of sudden death. But lightning may destroy life like a powerful galvanic shock, by producing such a violent convulsion of every muscle in the body that muscular irritability ceases almost at once. The rigidity in this case may be of such short duration as entirely to escape notice. Allowing for the difference in the relative power of lightning and galvanism, the greater effect of the former may reduce the duration of muscular irritability to the fraction of a second, and that of cadaveric rigidity in a corresponding degree, so that no trace of it may remain even a few minutes after death (op. cit. p. 209). Ranke has made the curious observation, that there is a difference in the conducting power of living and dead muscle, in reference to electricity. Contrary to that which might have been anticipated, he found that dead muscle was a much better conductor than living muscle; and he traced this increase in conducting power to the presence of certain products of decomposition which do not appear until after death.

It has been observed, as a general rule, that cadaveric rigidity does not

affect the relative position of the parts to which the muscles are attached; but a peculiar condition of the *hands* of the dead, observed by M. Villermè, would tend to show that in dying, the fingers assume a certain position by virtue of the contraction of the flexor muscles connected with them; although it is not quite established, whether this contracted state of the fingers takes place at the same moment with the commencing rigidity of the body, or whether it is not an immediate consequence of dissolution. M. Villermè has remarked, that in a dead body, the thumbs are always bent inwards towards the palms of the hands, the apex of the thumb being opposite the base of the little finger; and the thumb itself being covered by the four fingers of the hand. M. Villermè found this condition in many dead bodies which had not been disturbed. Devergie supposes that this position of the thumbs depends on a convulsive action of the fingers at the last moment of life; and as death may take place without any convulsive action, the appearance may be in some instances wanting. This sign of death, if it can be so called, is of but little importance; it will, however, be found in a large number of cases where there has been no interference with the hands. (Ann. d'Hyg.' 1830, 2, 420.)

There is another condition of the *hand* in the dead which calls for notice. If the hand of a living person is held before a strong light, it will be found to be translucent, and of a deep red colour from the transparency of the fluid blood circulating through it. The hand of a really dead person thus examined is stated to be in all cases opaque owing to the opacity of the coagulated blood. In applying this as a test, we must remember that a horny or hardened state of the cuticle, or a diseased condition of parts, may interfere with this translucency in the living subject: it is always better seen in the young and in those whose hands are thin. In these cases the fingers appear to be formed of a mass of blood; they have a deep red tint, except about the joints, where the colour appears lighter.

The Eyes.—Shortly after death, the cornea becomes dull, its brightness and prominence disappear, the globe becomes collapsed, and, after a time, the surface of the membrance is wrinkled. Louis long since observed, that the eyes of the dead became flaccid and soft in a very few hours after dissolution, and that a film was formed over them; this condition he considered to be characteristic of death. It is necessary to observe, however, that while this appearance is not always met with in the dead body, it is sometimes found in the living. In those who have died from apoplexy, or from the inhalation of carbonic acid gas, the eyes have often preserved their brilliancy and prominence for a length of time. This has also been observed in those who have been poisoned by prussic acid, cyanide of potassium, or the essential oil of bitter almonds. Incipient putrefactive changes may, by forcing the blood towards the head, cause a prominence and brilliancy of these organs, in those bodies in which they were dull and collapsed soon after death. On the other hand the film over the eye and the collapse of the globe have been observed in cases of malignant cholera several hours before death, and while the heart was still beating. ('Ann. d'Hygiène,' 1848, 1, 104.) M. Larcher has pointed out a new sign which he calls cadaveric imbibition of the globe of the eye. This appears in the shape of a blackish stain on the sclerotic coat on the outer side. This is at first, slight but becomes gradually deeper. It is followed by a similar patch or spot on the sclerotic in the inner side. They extend towards the centre of the eye, approaching each other, and forming the segment of an ellipse. This appearance is probably due to the sclerotic becoming thinner in these parts by evaporation and the dark pigment showing itself through it. M. Larcher describes this mark as the forerunner of putrefaction, following rigidity but preceding even the

green tint which is seen in the skin of the abdomen at the commencement of this process. ('Ann. D'Hyg.' 1869, 1, 468.) Küssmaul states, that no conclusion can be drawn, from the width of the pupils in death, as to the diameter which they presented at the latest period of life. This statement is of some practical importance in reference to post-mortem appearances in cases of alleged narcotic poisoning. M. Ripault noticed that in real death, the iris is perfectly flaccid. This is seen when the globe is compressed in two opposite directions at the same time. If the person is living, the pupil retains its circular form, notwithstanding the compression. If dead, the circular form is lost, and the aperture becomes irregular. Dr. Fleming has noticed that a solution of atropia, which by causing dilatation of the pupil would in a few minutes reduce the living iris to a mere line, has no action on the iris of the dead eye; but this result probably depends on the time after death at which the liquid is applied. Jobst and Hesse found that two drops of an aqueous solution of physostigmia (the poisonous alkaloid of the Calabar bean) applied to the eye of a rabbit an hour after death from natural causes, caused the pupil to contract to one-fourth, compared with the other eye, and it remained in this condition. ('Chem. News,' March 5, 1864, p. 109.) In cases of catalepsy or trance simulating death, the pupil retains its contractile power. It contracts under a strong light and dilates when the light is withdrawn. In real death the pupil is not affected by light.

The Skin.—After dissolution, the skin is observed to become extremely pallid and waxy-looking, owing to the absence of all circulation. In some parts it becomes covered, as the body cools, by livid discolourations (cadaveric ecchymosis); this is especially the case in those instances where death has taken place by sudden violence. One of the most striking changes in the skin is its entire loss of elasticity. In the living body, if any part of the surface be compressed, the skin will readily return to its original form on removing the pressure. Thus, in a doubtful case, a flatness of those parts which have been allowed to lie upon an even surface may be regarded as a sign of real death, provided the other concomitant changes are observed. It is almost unnecessary to remark, that if certain diseases have the power of depriving the skin of its elasticity, the history of these cases, or a superficial inspection of the body, will suffice to show to what cause the want of elasticity is to be attributed.

Among the signs of death has been enumerated *coagulation of the blood.* M. Donné suggested that, in order to determine the reality of death before the access of putrefaction, a small portion of blood should be drawn from a vessel, and it should then be observed whether it coagulated or not. If instead, of a red homogeneous *coagulable* liquid we obtain only a reddish coloured uncoagulable serum, from which the particles speedily subside as a red sediment, we shall be justified in inferring that life has ceased—a conclusion at which we could not arrive if even the smallest portion of coagulum should be formed. This appears to be a fair physiological test, and easy of application. When the blood has once coagulated, there must be an arrest of circulation; and although it might become again fluid, this would be only under the influence of putrefaction, and it would not thereby recover a coagulating power. One of the great characters of blood effused from a *living* body is, that it coagulates speedily after its effusion. Thus, drops from an artery thrown on furniture or a wall speedily consolidate, assuming an oval or long elliptical form, the narrow point downwards, and at this part will be found the coagulum of fibrin locking up the red colouring matter. Blood sprinkled from a dead body is more liquid; it forms a long irregular drop or streak, and only dries up by evaporation; it has no coagulating property.

The blood coagulates in most cases after death, but at a variable time after

the cessation of the heart's action. When blood is removed from the living body, coagulation commences in from five to ten minutes. In the dead body, it probably does not commence until it begins to cool. Hence the fact of coagulation does not prove that the person is living. Dr. Wilks has observed that when a body is examined eight or ten hours after death, it is not unusual to find the blood which may have flowed from it as a liquid, forming a firm clot on the table; and that which is effused into the chest during the examination often forms after some time a very firm coagulum. ('Guy's Hospital Reports,' Oct. 1863, p. 183.) It has been stated that the blood of persons killed by lightning does not coagulate, but this statement is erroneous. Certain diseases appear to influence the coagulation of the blood. Mr. Savory has observed that coagulation has been partial or imperfect in cases of death from delirium tremens; and it is well known that in rapid death from certain vegetable poisons the blood is found fluid and of a darker colour than natural, even when the examination is made soon after death.

CHAPTER 4.

CADAVERIC SPASM—EVIDENCE OF MURDER, SUICIDE, OR ACCIDENT FURNISHED BY THE POSITION OF A DEAD BODY—WEAPONS FOUND IN THE HANDS—MUSCULAR IRRITABILITY—TESTS OF ITS PRESENCE—POST-MORTEM CONTRACTILITY—ALLEGED PREMATURE INTERMENTS—PROOFS OF THE REALITY OF DEATH—DEATH-TRANCE —APPARENT DEATH IN THE DROWNED AND IN NEW-BORN CHILDREN.

In reference to persons found dead, the position or attitude of the body, if undisturbed, may often throw an important light on the mode of death, and on the question whether the deceased had died by his own act or by the act of another.

Cadaveric Spasm.—It has been already stated that, as a general rule, the muscular system passes into a state of relaxation at the moment of death. This is observed in cases of tetanus of a severe form, whether produced by disease or by poison. Half a grain of strychnia was given to a rabbit. After several fits of convulsions the animal died; respiration ceased in twenty-three minutes. At this time there was perfect flaccidity of the body, limbs, and joints; but this condition lasted but for a very short period. The animal was placed on its back, and the legs raised, for the purpose of making an examination of the chest. In ten minutes the body became, while still warm, perfectly rigid in the attitude in which it was held—the fore-legs remaining stretched upwards and wide apart. If an animal dies in a convulsion, and the body is not disturbed, the tetanic spasm may pass rapidly into cadaveric rigidity. This has been called tetanic rigidity, but it is in fact cadaveric rigidity or muscular spasm showing itself in a persistent form after death. When the rigid state is destroyed by forcibly bending a joint, the limb will not return to its position like one which is contracted by a tetanic convulsion. Engel has seen this transition from spasm to rigidity; and I have noticed, in experiments on animals, a rigid condition assumed after death without any apparent relaxation of the muscles. Sommer and Clemens have observed, in fatal cases of rheumatic tetanus, that the spasm of the muscles of the jaw, neck, and back passed immediately into cadaveric rigidity. (Küssmaul, loc. cit. 490.)

That spasmodic condition of the muscles which passes into rigidity in death from tetanus, may also show itself in other cases of strong muscular contraction at the moment of death. Thus a body may stiffen or become rigid in an

attitude of attack or resistance; the members may retain in a rigid state the position which the last act of volition imparted to them. The term cadaveric spasm has been applied to this condition of the muscles: it is nothing more than muscular rigidity or violent muscular contraction so rapidly followed by the rigidity of death, that the muscles have not relaxed on the cessation of life.

M. Marc first directed the attention of medical jurists to this subject in reference to a case which will be hereafter related. He considered that this form of rigidity might occur as a result of sudden death from apoplexy, and he quotes the following case as an illustration:—An aged man, while at the theatre with his family, rested his forehead upon his hands, which were crossed in front of him, while with his elbows he leaned on the front of the box. It was thought that he had gone to sleep in this attitude, and he was not disturbed; but after the performance was over and the persons were about to leave the theatre, it was found that he was quite dead. ('Ann. d'Hyg.' 1832, 1, 602.) I knew an instance in which a lady who had retired to her bed-room in perfect health was found dead the following morning. She was kneeling at a chair in the attitude of prayer, and her body had become rigid in this position. This was also a case of sudden death from apoplexy. In some instances in which chloroform vapour has caused accidental death, the hand firmly grasping the handkerchief has been found applied to the mouth and nostrils, as if the deceased were still breathing the vapour.

From what has been elsewhere stated (p. 59) this singular condition of the body is more likely to present itself in those cases in which there has been great muscular exertion, and when muscular irritability is nearly exhausted at the moment of death. Corpses have thus been seen stiffened on the battle-field in the last attitude of life. Mr. Russell thus describes what he saw after the battle of the Alma in the Crimean War:—'The attitudes of some of the dead were awful. One man might be seen resting on one knee, with the arms extended in the form of taking aim, the brow compressed, the lips clenched, the very expression of firing at an enemy stamped on the face, and fixed there by death: a ball had struck this man in the neck. Another was lying on his back, with the same expression, and his arms raised in a similar attitude, the Minié musket still grasped in his hands, undischarged. Another lay in a perfect arch, his head resting on one part of the ground and his feet on the other, but the back raised high above it.' Cases of a similar kind were noticed in the Italian war after the battle of Solferino, and in some of the battles in North America between the Federal and Confederate States. See p. 59; also 'Savory on Life and Death,' p. 192.

In cases of sudden and violent death, it is by no means unusual to find the body, or one or more of the limbs, rigid and fixed in a state of spasmodic contraction. This is sometimes witnessed in cases in which persons have died in full and robust health. The body of a suicide may be discovered stretched on the floor of an apartment, with the suicidal weapon firmly grasped in his hand. Razors and pistols are thus frequently found in the hands of suicides, whether recently dead, or whether they have been lying some time before they were discovered; and these instruments may be grasped or held under circumstances which would appear impossible, from their weight, were it not well ascertained, that the spasm which often ensues at the moment of death may be retained for a considerable period. In September 1826, a gentleman was found dead in a chair in his bed-room; he had shot himself some hours before his body was discovered. A discharged pistol was still held firmly in his right hand, and there was also a loaded pistol grasped in his left. Instances are frequently occurring, in which razors or knives require to be removed even with some force, from the hands of those who have destroyed

themselves. In such cases, the contractile power, impressed by the last fatal act of volition, persists until cadaveric rigidity has supervened.

Devergie observes, that, although in many cases the arms, at the moment of death, fall in a collapsed state by the sides of the body, there are numerous others in which their situation may throw some light on the manner of death. In one case of suicide by a pistol-shot, he found on entering the apartment, the right arm and hand of the deceased turned towards the side of the head, against which the pistol had been fired. A man, who had died from the effects of carbonic acid given out by a limekiln, was found with the left arm raised and supporting his head, the right semiflexed on the abdomen; the whole figure being that of a person quietly asleep. These are curious facts, and deserve to be borne in mind, for questions relating to them arise unexpectedly on trials for murder. Although apparently trivial, they may in some instances become the turning-points of the guilt or innocence of a person charged with murder.

In the case of *Lord William Russell*, who was murdered by Courvoisier in 1840, it was observed that one hand of the deceased firmly grasped the sheet of the bed, as if in a struggle against an assassin. The force here given to the muscles during life, had persisted after death: it had passed into what has been termed, for want of a better designation, 'cadaveric spasm,' and in this state the contracted hand had become rigid. This position of the hand of deceased furnished, among other circumstances, some evidence against the presumption of suicide. In drowning, it is by no means unusual to find, when the dead bodies are taken from water soon after the accident, that pieces of rope, an oar, grass similar to that growing on the banks, or weeds like those growing at the bottom of a canal or river, are firmly grasped in the hands. This is one of the strongest proofs which we have that the individual has gone into the water living. Part of a dress may be thus found grasped in the hand, and serve to identify a person accused of murder.

In general, when the dead bodies of the recently drowned are taken from water, the limbs are found relaxed; but this depends on the time at which they are removed. Convulsions sometimes precede death by asphyxia, but the effects of these on the body are generally lost when the person dies. Rigidity of the muscles takes place after death in water, perhaps more rapidly than in air. If the water is intensely cold, and the person has struggled violently, the last struggles of life may be indicated by the contorted state of the limbs persisting through rigidity. Mr. Beardsley, a former pupil, communicated to me the following case. A young man, while skating, fell through the ice of a pond about seven yards deep. This was in February 1847. He was not totally immersed, for he kept his head and shoulders out of the water above the ice, with his arms resting upon it; and as the ice gave way under his weight he sprang to a fresh portion. Before assistance could be rendered, he sank. The body was recovered the next day; it was found at the bottom of the pond, beneath the hole in the ice. The arms of the deceased were stiff, and still retained the position in which he had rested upon the ice: his legs were quite extended, and the muscles on the fore part of the thigh were very much contracted, as if they had been powerfully exerted in keeping him erect while he was hanging on the ice. There was no appearance of his having attempted to breathe, after he had gone below the water. His countenance was quite natural, and there was no water or froth in his mouth; the external appearances resembled those which are seen in a body immersed after death from some other cause. There was no internal inspection. Mr. Beardsley's opinion was, that the water being about 32°, the man was in reality killed by cold, or frozen; and there is no doubt, that if this did not operate as the direct cause of death, it materially accelerated it.

This case is of interest in reference to the fact of the bodies of persons who have been drowned at the same time by a common accident, being frequently found clasped in each other's arms. A contracted state of the muscles at the time of death may pass into perfect rigidity by the effect of cold water: and thus the attitude, or the last act of life of the individual, may be preserved.

In the case of *The Queen* v. *George* (Hereford Lent Assizes, 1847), a woman was indicted for the murder of her infant child by drowning it. When taken from the water (in the month of December), about nine days after the supposed murder, there were no marks of external violence. The arms and legs were contracted, and the hands closed. On inspection, the vessels of the brain were congested, the lungs were collapsed, and there was farinaceous food in the stomach, partially digested. The state of the windpipe, and the presence or absence of mucous froth, are not referred to. It will be seen from this description, that there was no appearance to indicate death from drowning with any certainty; and the medical witness admitted, that but for the discovery of the body in water, a suspicion of death from drowning would not have been entertained. From the state of the brain, death might have been caused by convulsions. The defence was, that the child had probably died of convulsions, and that, in order to dispose of the body, the prisoner had stripped it of its clothes, and thrown it into the water after death. The medical evidence failed to show that the child had died from drowning, and the prisoner was acquitted. The rigid and contracted state of the child's limbs appears to have created a difficulty in the defence. The clothes of the child were neither cut nor torn, and the witness considered, that had the limbs been so contracted as they were when the body was found, these could not have been removed without cutting or tearing. The medical question therefore was, whether the state of the child's limbs did not prove that it had been put into the water while living. As the usual appearances of death from asphyxia were entirely wanting, it is proper to consider whether there may not be some explanation of the facts consistently with death before immersion. The admission made by the witness in cross-examination, appears to supply all that is necessary for this explanation. If the child had died of convulsions, if the clothes were then removed, and the body thrown in immediately, the sudden effect of the cold water might have occasioned the contraction of the limbs; or the child may not have been really, but only apparently dead, when the mother stripped it and placed it in the water. If some time had elapsed before immersion, so that the body had become cold, then the limbs would have been found either relaxed, or stiffened in a straight position. The persistence of this contracted state for so many days may be explained by the immersion having taken place at the coldest season of the year.

The dead body may be found with some article grasped in the hand. (See case, 'Ann. d'Hyg.' 1829, 1, 464.) It may be the hair of the deceased or the prisoner's hair torn off in the struggle for life; and on this point an important question of identity may be easily raised. (*Reg.* v. *Ellison*, Bodmin Summer Assizes, 1845.) In a case which was tried some years since, a man was charged with the murder of a woman with whom he cohabited. The body of the deceased was found lying dead in the house, with such injuries about the head, as to render it certain that she must have been murdered. In her right hand was found a considerable quantity of brown hair, and in the other hand some grey hair, grasped evidently in the struggle for life. On the morning following the murder, the prisoner went to a hairdresser's in the town, and desired to have his hair and whiskers cut. This man observed

that the hair and whiskers had been recently cut, and evidently by some one unaccustomed to hair-cutting. There was a difference between the hair of the whiskers and that of the head, the former having turned grey. The hairdresser was of opinion, that the hair found in the hands of the deceased, was of the same colour and kind as the hair of the prisoner. This, with other corroborating circumstances, led to his conviction. In a case which occurred to Dr. Marc, a woman was found assassinated in her house, and when the body was discovered, a small snuff-box was still held firmly in one hand. This proved that the murder must have taken place very suddenly, and without any resistance on the part of the deceased. ('Ann. d'Hyg.' 1829, 1, 465.) Great light is often thrown upon a question of suicide or murder by attention being paid to these minute points connected with a dead body. It has been elsewhere stated (p. 65) that a weapon may be found grasped in the hand of a person who has destroyed himself; and when a weapon is thus found, the fact is strongly confirmatory of suicide. It does not seem possible that a murderer could simulate this condition after destroying the deceased. The hand of a dead person, while still warm and pliant, could not be made to grasp a weapon in the same way as that hand which had firmly held it by powerful muscular contraction at the last moment of life. At any rate, the attempt to produce this appearance has signally failed. At the trial of a man named *Saville*, in 1844, it came out in evidence, that the deceased, his wife, was found dead with her throat severely cut, and there was a razor, not grasped, but lying loosely in her hand. There was no blood upon the hand which held the razor, and this, together with the fact of its being loose, rendered it probable that the weapon had been placed there by some person, after the throat of the deceased had been cut.

The case of the woman *Gardner* (*Reg.* v. *Gardner*, C. C. C., Oct. 1862) was marked by a similar incident. The woman had died from several wounds in the throat which could not have been self-inflicted, and a common table-knife was found loosely lying in her right hand, with the back of the blade towards the palm of the hand, and the weapon in the direction of the length of the body. According to the evidence of the medical witnesses, the principal wound in the throat, was of such a nature that it could not have been inflicted with the right hand. This at once proved that there had been murderous interference. On these occasions it may be suggested that a weapon, although grasped by an alleged suicide to inflict the death-wound, may either drop from the hand or be found loosely in it, as a result of the relaxation of the muscles in death. This must be admitted; hence the mere fact of a weapon being found loose, should not be taken as evidence of murder, unless other circumstances—such as the nature of the wound, the freedom of the hand from blood, the position of the body, &c.—concur to prove that the act was not one of suicide. Küssmaul asserts that the fact of a weapon, whether a razor, knife, or pistol, being found firmly grasped, should not be taken as any proof of suicide; because if this position be given to the fingers when in the stage of relaxation, they will in that of rigidity, embrace the article so closely, that it will be difficult to disengage it. He gives this as a mere surmise, and not as being based on any experiment. That it should present itself as a serious objection in practice, we must infer that assassins are fully aware of the forensic necessity of causing the hand of the victim to grasp the weapon with the greatest firmness, and that they can remain by the corpse thus holding the hand clenched, until the fingers have stiffened with sufficient firmness to retain it! Assuming this improbable state of things, other circumstances, as in Gardner's case, may show that the weapon after all has been placed in the wrong hand, or that the blood-marks on it and on the hand, have no correspondence. The difficulty of thus en-

deavouring to imitate an act of suicide, when the facts are properly observed and compared, will be apparent from the following case, which was tried at the Liverpool Assizes, 1855 (*Reg.* v. *Heywood*). The deceased in this case, a female, was found dead in bed with her throat cut. The medical evidence showed that the wound was six inches from right to left, extending across the throat to a point under the left ear: the upper portion of the windpipe was severed, and the jugular vein, as well as the muscular branches of the carotid artery, were divided. The medical witnesses considered that the wound in the throat had not been inflicted by herself. It was such a wound as a *left*-handed person would have inflicted, and the hand inflicting it, as well as the weapon, could not have escaped being marked with blood. It appears that when the body was found, there was a razor in the *right* hand, not tightly held. The arms were folded across the chest, the right hand resting on the left, the back of the razor being towards the person of deceased. There was *no blood* on the *hands*, arms, or chest, and only one small spot on the razor. There was blood on the under-side of a pillow, and a corresponding stain on the bolster, showing that this must have been turned over, and the head placed on the clean side after the infliction of the wound. All the circumstances concurred in showing, that an attempt had been made to simulate an act of suicide, while the facts were only consistent with homicide. The prisoner was connected with the act by the moral as well as circumstantial evidence, and he was convicted and executed. Neither during nor after the cessation of rigidity could this spasmodic condition of the muscles of the hand be simulated; in no case, it appears to me, is it possible to give an appearance of grasping, similar to that which is occasionally found after death as a result of cadaveric spasm and rigidity.

It is strange that the discovery of a weapon thus held in a dead hand should have been assumed to furnish evidence of murder. The following case is, in this point of view, worthy of notice. On July 5, 1835, a medical man at Bordeaux was called to examine the body of a gentleman supposed to have been murdered. Upon entering the apartment, which had been left undisturbed, he found the deceased perfectly dead, sitting in an arm-chair by the side of the bed, the left elbow resting upon a bolster. His right hand, which held a recently-discharged pistol, rested upon the middle of the right thigh, the greater part of the barrel projecting over the inner surface of the thigh, so that the slightest motion of the part would apparently have been sufficient to cause it to fall on the floor. The bullet, which could not be found, had fractured and traversed the left parietal bone, after having torn off nearly the whole of the face. The clothes of the deceased were saturated with blood; a large quantity had also drained through the seat of the chair, and had formed a considerable clot on the floor. The temperature of the body indicated that the deceased had not been dead above two hours; and it was at about that time that the discharge of a pistol had been heard by some of the neighbours. The other facts ascertained relative to the case were that the deceased, who was about sixty years of age, had never shown any disposition to destroy himself; and there was no moral circumstance which seemed likely to have acted as an exciting cause, except perhaps the loss of a lawsuit by a favourite sister, which, however, was deemed scarcely sufficient to explain the event. He had a son, who lived in the house with him, and slept in the same room. They were both dissipated in their habits. On the morning of the event, after breakfast, the son (according to his own statement) threw himself on his bed, which was by the side of that of his father; he fell asleep, and knew nothing of the circumstance until he was aroused out of his sleep by the discharge of a pistol. The son was accused of having destroyed his father, and of having placed the pistol in the hand of his parent after death, in order to

lead to the supposition of suicide. This circumstance seemed so much the more probable to the police officers and those who were present at the finding of the body, since, when the hand with the pistol was carefully carried to the position in which the weapon must have been held by the deceased in order to have committed the fatal act himself, and the hand was afterwards allowed to fall by its own weight, the pistol each time fell from the hand to the floor. Besides, on the moral side of the question, it was shown that the son would be benefited by the death of the father.

The medical examiner having duly reflected on the position in which the deceased was discovered, satisfactorily accounted for the hand retaining the pistol after death by the contractile state of the muscles, from the effect of volition at the moment of death being sufficiently strong to prevent the weapon from falling. The experiments performed with the hand and pistol subsequently were very properly stated to be unsatisfactory; since, when this contracted state of the muscles has been once destroyed by much handling, it could not be restored. The specious argument thus founded upon a popular error was, by the tact of the medical witness, satisfactorily refuted. The reporter of the case candidly confesses that, owing to his having been misled by popular prejudice, he was at first almost inclined to believe that the son had been guilty of parricide; and probably if a hasty and careless examination had been made, or if the body had been officiously interfered with, previously to its being seen by a medical man, the son might have been committed for trial on a charge of murder. So soon as this apparently physical proof of his guilt had been explained away, it was then seen that all the other circumstances rebutted the presumption of homicide. The discovery of a weapon so held, may be considered as one of the best possible proofs of suicide.

The postures in which the bodies of persons found dead from any cause are discovered may, in numerous cases, be brought forward to support a charge of murder, or, at least, of criminal interference; but great care is always required in the application of medical principles to the elucidation of these cases, as well as a good general acquaintance with the various phenomena immediately preceding and following death.

As the body becomes rigid in the position in which it happens to be on cooling, and assumes exactly the attitude of the person at the time of death, careful observation may, in some instances, show whether, in a case of violent death, it was or was not interfered with *before* rigidity took place. A question of this kind arose in the following case. The deceased was found lying dead in the room where the murder had been perpetrated; there were marks of blood in various places, and the body had evidently been removed from the spot where it had fallen: it had been laid out. The clothes had been tucked round it, and a piece of black cloth had been placed over the face. A question arose as to whether the body had been thus removed before or after rigidity occurred? As it was found evenly laid out, the probability was, that it had been removed while the limbs were pliant; and they had then become rigid in this position. If a body be removed during the state of rigidity, it may be in some instances indicated by the position of the still rigid limbs not being adapted to the surface on which the body is found lying. It has been already stated that the first effect of death, in the absence of cadaveric spasm, is relaxation of the muscles; the body then disposes itself according to the surface on which it happens to be lying; the arms or legs may be more or less fixed or contorted, and become rigid in the position which they assumed by gravitation at the time of death. The lower jaw, if left to itself, drops and becomes rigid in this position. When

a body is found rigid, with the members evenly extended, and the jaws closed, this is, *cæteris paribus*, strongly indicative of interference while there was warmth and pliancy in the limbs. When, on the other hand, the body is found rigid and doubled up, with the limbs more or less twisted lying on an even surface like a bed, the probability is, according to circumstances, that the body has been moved from the spot in which the person had died, and in which rigidity had supervened. In suicidal hanging, the body, and especially the extremities, are now and then found twisted in a singular manner around articles of furniture. In such cases, the general muscular convulsion, at the moment of death, will physiologically explain, what to uninformed persons may appear physically incompatible with the deceased having destroyed himself.

The following case will serve as an illustration of the occasional importance of these inquiries. In June 1855, *Robert Reid* was tried before the High Court of Justiciary, at Edinburgh, for the murder of his wife. A report of this trial was published by Dr. Fletcher, who, although not a witness, gave his medico-legal assistance to the prisoner. Among the medical circumstances which gave rise to conflicting opinions was one which referred to the posture in which the body of the deceased was found, at half-past two o'clock, on Saturday, September 20, 1834, the day of the supposed murder. It was thus described by the witnesses. 'She (deceased) was sitting on the floor by the side of the bed, nearly naked, with a portion of the bed-clothes wrapt around the lower part of her body; the head erect, but inclined a little backwards and to one side, the face being towards the bed. The left arm hung down by her side, with the back of the hand on the ground, the right arm resting by the elbow on the bed, and maintained in the upright position without any further support, as if she had been in the act of putting it to her face. The legs were crossed under the trunk, the left being less protruded than the right.'

This extraordinary posture was presumed by all who saw it and by the medical witnesses for the prosecution, to be such, that the deceased could not have assumed it herself in the act of dying; and this was rendered still less probable when it was considered that the cervical vertebræ were fractured, and one of them was displaced, so that she had probably died a violent and very sudden death. The attitude appeared to be also quite irreconcilable with the supposition of death from accident or suicide. The chief question seems to have been, whether, admitting that the prisoner had actually placed his wife in this posture, the maintenance of it was to be ascribed to a convulsive spasm, simultaneously occurring with death, or to the supervention of ordinary cadaveric rigidity. If the posture were admitted to have been due to cadaveric rigidity naturally supervening, then the inference would be that deceased had been dead, at least, some hours. The prisoner was proved to have been at home from nine until half-past nine: the deceased's body was discovered at two, and as the prisoner had not been at the house between half-past nine and two, so it followed that, supposing him to have been guilty, he must have committed the murder during the half-hour that he was at home. Hence, cadaveric rigidity must have come on in four hours and a half after death. On the other hand, it was urged, that the attitude of the body, and the singular perpendicular position of the right arm, were due to a spasmodic contraction of the muscles in a fit, at the moment of death, persisting under the form of cadaveric spasm. The non-medical witnesses stated that the body of the deceased when found was perfectly flexible, and the arms and legs so pliant, that they could be easily stretched down; indeed, the whole body was so yielding as to admit of its being directly laid out at length on the floor. The body was partially warm when first found, but, as it has been already observed, this is quite compatible with the occurrence of rigidity.

Certainly, however, where a body is warm and the members are easily moved from their position, the presumption is rather in favour of the fixed posture being due to muscular spasm than to cadaveric rigidity.

The witnesses for the prosecution considered that the posture of the deceased was owing to simple rigidity. Dr. Fletcher attempts to explain the facts by supposing that the deceased had probably fallen in a fit while getting out of bed, during the absence of the prisoner; admitting that the prisoner might on his entrance, at about nine o'clock, have attempted to raise the body, and thus have given the erect position to the trunk, while the perpendicular position of the arm was entirely due to spasm. It was urged that the woman had been previously subject to slight paralysis and convulsive fits, and that the occurrence of a fit, under the circumstances, was not unlikely. The position was not such as we might suppose a body to assume when a person has died under a cataleptic seizure. On the other side, it was considered to be improbable that the prisoner could have placed the deceased in the attitude in which she was discovered, admitting her to have died in any other posture—since at the time he did it, the body must have been either rigid or not. If it were rigid, he could not easily have bent the members from the position which they had already assumed; and if it were not rigid, he must have used artificial means to keep the members and trunk in the extraordinary position in which they were found: for it was not likely that he would have purposely held her head and arm in such a singular attitude, until her body had become fixed. Indeed, in order to accomplish this, he must have waited until it had become cold, whereas it is stated to have been found with some warmth and pliancy about it. Besides, it would be impossible to assign any reason for so doing, since he would be ignorant of the medical difficulty connected with it.

The prisoner was discharged on a verdict of not proven, because it was not satisfactorily made out that he had really caused his wife's death. The state in which the deceased was found, created a presumption that she had died from natural causes not long before the discovery of her body; therefore, at some time between-half past nine and two, and while the prisoner was absent from the house. The account of this case, as given by Dr. Fletcher, is of course made out in the most favourable way for the prisoner. Having been employed as medical counsel on the occasion, he suggested many ingenious explanations for circumstances which were certainly very strong against the prisoner. The verdict of 'not proven' sufficiently attests the opinion of the jury; and had the medical evidence respecting the cause of death from violence been a little more clearly made out, there is hardly a doubt that the prisoner would have been convicted.

Whether this was a case of death from natural causes, or, as alleged, from an injury to the spinal marrow, we must regard the attitude in which the body was discovered as very unusual. There were difficulties in the way of an explanation, whether we suppose the prisoner to have interfered or not with the position of his wife's body. Had a proper examination been made by medical men when it was first discovered by the neighbours, some of these difficulties would not probably have existed. With a fracture of the dentiform process, and a dislocation of the first and second vertebræ, it is not likely, unless the body had been supported mechanically by the clothes which it is said presented the appearance of having been dragged off the bed with it, that a person so injured would die in the attitude in which the deceased was discovered, or that she could have had the power to assume it spontaneously after such a severe injury to the spinal column. The probability is, that the body would have been found lying on the floor.

A question was raised upon this trial respecting the duration of muscular

spasm after death: and this may become at some future time, a point upon which a medical witness may be required to express an opinion. There is but little doubt, from numerous collateral facts, that it may remain for a considerable time after death and even pass into cadaveric rigidity, *i. e.* the posture assumed by a limb from spasm at the moment of death, may be retained as the posture of cadaveric rigidity, supposing the body not to have been disturbed. An instance is reported, in which a drowned subject, after having remained in water from twelve to fourteen hours, was drawn up with his hands still grasping firmly the cable of a vessel, which he had caught hold of in the act of drowning. The bodies of persons drowned in a common accident, are found not unfrequently after twenty-four hours firmly locked together by their arms, when taken out of water cold and rigid. In persons who die under violent spasmodic contraction of the muscles, as in cholera and tetanus, whether from natural causes or the effects of strychnia, the state of spasm is sometimes preserved after death and passes into rigidity.

The attitude in which a dead body is found rigid, may easily give rise to an erroneous suspicion of murder. The following case has been reported by M. Marc:—The deceased, *Courbon*, was found dead in a ditch; his head was bent upon his chest, and the lower part of the trunk was so curved, that the whole weight was borne by the neck. The body was very rigid, but there were some slight traces of warmth when it was found. On inspection there were all the appearances of apoplexy, and the deceased was well known to have been of drunken habits. Notwithstanding these facts, two persons were convicted of murder upon some loose evidence—principally on the ground that the unnatural position in which the deceased's body was found could only be explained on the supposition of murderous interference. The accused were condemned to the galleys for life; but after two years' punishment, a proper medical investigation of the facts was for the first time instituted, and they were discharged. The evidence established that the deceased had died of apoplexy; and that the body had assumed the peculiar position in which it was discovered owing to the deceased having fallen into the ditch in a state of drunkenness, by which he was rendered helpless and incapable of extricating himself. ('Ann. d'Hyg.' 1832, 1, 569.) While rigidity may sometimes indicate murder, or some form of violent death, by fixing the body in a position which it could not naturally have assumed, and which cannot be easily altered during the rigid state, we must beware that we do not give an undue importance to this sign of death as a proof of violent usage. This caution is especially required in the cases of drunkards, for the body of a person who dies in a fit of drunkenness may be found contorted and disposed in a way which might be apparently incompatible with accident or suicide.

4. Muscular Irritability.—In order to determine the reality of death, it has been proposed to test the irritability of the muscles by the application of an electric current. If a voluntary muscle laid bare for this purpose, does not contract under the application of this stimulus, the inference is that the person is dead; but if it should contract under these circumstances, it furnishes no proof that the person is living, in the ordinary meaning of the word. It has been elsewhere stated that the heart and involuntary muscles, which are readily affected by a mechanical stimulus soon after death, lose their irritability or power of contraction, even under a galvanic current, much sooner than the voluntary muscles. As a result either of disease or exhaustion, of the action of certain poisons, or of the effect of lightning, the irritability of the whole muscular system may be entirely destroyed at the time of death; in these cases no stimulus would excite muscular contraction. Under these circumstances rigidity and putrefaction so rapidly follow, that the application of

electricity for additional evidence would be superfluous. On the other hand, in certain cases, as in the body of a decapitated man, whose case is recorded by Nysten, the irritability of the muscles may remain for twenty-six hours after death. In short it is now known, that until cadaveric rigidity commences in the body, muscular irritability is retained. When this commences it begins to disappear. Contractility of the muscles under the current would, therefore, prove either that the person was living, or that the body was in the first stage of death. All the muscles do not retain this irritability under the electric stimulus for the same length of time, nor do they all lose at once their susceptibility of contraction. One degree of stimulus may excite them, while another may not. According to Dr. Bence Jones living muscle has an alkaline reaction, while dead muscle is acid.

Dr. Dowler, of New Orleans, has shown by numerous experiments on the recently dead body, that post-mortem contractility may be excited by slight blows on the muscles given with the hand or any weapon, and thus electricity may be dispensed with. When the arm of a recently dead person was extended at a right angle with the trunk, a blow over the biceps muscle, not sufficient to injure a living person, caused the forearm to bend, carrying the hand to the chest repeatedly. In fact, before rigidity set in, the arm of this corpse, by the mere effect of slight blows, performed supination, pronation, and flexion most perfectly. This effect of slight mechanical violence is most distinctly observed within *half an hour*, but Dr. Dowler has seen it manifested as late as six or seven hours, after death! It disappears when rigidity sets in. ('Experimental Researches on Post-mortem Contractility,' by Bennet Dowler, New York, 1846, p. 601.)

It is a curious fact that the blood has no appreciable influence upon the post-mortem contractility of the muscles, because when the limb was severed from the trunk, and drained of its blood, its action was not thereby diminished. ('Am. J. Med. Sc.,' Oct. 1846, p. 440.) Contractions as the result of slight blows were observed in forty-three cases. The contractions were in many cases so forcible, as to cause a heavy weight to be lifted by the limb in which they occurred. The integrity of the corpse was not necessary; they were excited some hours after the dissection of the body, and after the limbs were severed from the trunk. Dr. Dowler considers that these muscular contractions have occurred spontaneously after the death of the body. Spontaneous movements in a corpse have been seen after death from cholera (case by Mr. Rumsey, p. 11), and the same may take place after death from yellow fever and other diseases. Dr. Dowler suggests that the changes in the position of the limbs of bodies sometimes observed after death, which have given rise to tales of premature interment, may be explained by the occurrence of spontaneous post-mortem contractions, depending on the long retention of muscular irritability in a high degree. Haller endeavoured to lay down the order of cessation of this irritability in different muscles after death. Many physiologists since his time have also occupied themselves with this question. Haller found that it varied according to the kind of stimulus employed: thus the irritability of the heart was excited by *mechanical* agents for a longer period than any other part of the muscular system;—a circumstance which was supposed to account for the reports of persons having been dissected alive, to be found recorded in some works on Medical Jurisprudence, an accidental puncture by the knife or forceps having given rise to contractions of this organ. But to admit this explanation, we must suppose that the body was inspected within one or two hours after death.

Nysten concluded from his observations that the successive disappearance of muscular irritability in the bodies of decapitated persons took place in the following order:—1. The left ventricle of the heart. 2. The stomach and

intestinies. 3. The urinary bladder. 4. The right ventricle. 5. The œsophagus. 6. The iris; and 7. The voluntary muscles of the body.

The power of making the muscles contract under the electric current, has been found to vary according to the nature of the disease of which the individual died. When it was such as to exhaust the strength, the time was very short. From experiments performed at La Charité, it appeared that in death from peritonitis, irritability ceased in about three hours; in phthisis, scirrhus, and cancer, in from three to six hours; in death from profuse hæmorrhage, or from mortal leisons of the heart, in about nine hours; in apoplexy with paralysis, in twelve hours; and in low fevers and pneumonia, the irritability disappeared in from ten to fifteen hours. In these experiments, the muscles of the trunk and limbs alone were examined; since it is upon these, should the necessity ever occur, that a practitioner must operate. Although the periods are thus laid down in figures, yet the results must be regarded only in the light of approximations to the truth.

We have now to apply these different data, connected with death and the changes in the dead body, to the solution of some medico-legal questions—such as the reality of death and the period at which death has taken place.

The Reality of Death.—This question, of course, can only be raised in the period preceding the occurrence of putrefaction; therefore our observations on this point may be restricted within a very narrow compass. The question, indeed, might be passed over altogether as unimportant, were it not that many men ranking high in the profession have devoted much attention to the subject; and have thought themselves justified, from their observations, in declaring that premature interment was not unfrequently the means of consigning living individuals to the tomb. There is something terrible in admitting the bare possiblity of such an event; and, therefore, we ought not to reject the supposition, without examining the numerous cases which have been brought forward in support of it. In the work of M. Fontenelle, published some years since, *forty-six* cases are recorded, either of the premature interment of the living, or of apparent being mistaken for real death. From a careful examination of all these cases, it appears to me that the greater number of them are derived from such sources, as to render them perfectly inadmissible as evidence of what M. Fontenelle so strenuously endeavours to prove. He has collected these cases from every source, whether scientific or not, from the time of Plutarch downwards. This very circumstance would make reasonable men distrust those instances of supposed death which are undoubtedly authentic, did not the facts appear explicable on the most common physiological principles.

The fears which works like that of M. Fontenelle are likely to excite, respecting premature interment, have been kept up by other French writers. M. Carré maintained that there was *no certain sign* of death but putrefaction; and that no body should undergo interment until this process had become plainly manifested. According to this gentleman, a *presumption* of death may be deduced from a great number of signs; a *probability*, from the combination of some of the most important, such as the collapse of the eyes, and especially cadaveric rigidity; but *absolute certainty* can be obtained only by the occurrence of the putrefactive process. Like other terrorists, M. Carré attacked each sign of death individually, but he ignored the fact, that a judgment in proper hands was always formed from a combination of many signs or conditions; and medical men are not responsible for the results, when the decision of an important question of this kind is entrusted to ignorant and uneducated

persons. A petition was, on one occasion, presented to the French Chamber of Deputies, in which the petitioner declared that he had known six interments of living persons to have taken place within a period of eight months! Resting on similar authority, M. Carré asserts that since 1833 there have been forty-six cases of premature burial. Among these, twenty-one persons returned to life at the time they were about to be deposited in the earth: nine recovered owing to the affectionate attentions of their relatives: four from the accidental falling of the coffins: two from a feeling of suffocation in their coffins: three from the punctures of pins in fastening the shrouds: and seven from unusual delay in the funerals: and, it is added, after this marvellous recital, that the decease of all these individuals was officially attested! A statistical calculation is then made by him from the deaths which occur annually in Paris, of the average number of persons who were likely to be buried alive.

Statements of this kind can only be received with incredulity, since no particulars by which their accuracy can be tested are given. The cases of alleged premature interment that have yet been adduced, will not bear a close examination, as they are nothing more than the idle tales of ignorant and superstitious persons with the usual amount of exaggeration. In this country we have no official attestation of death by specially appointed persons; but if the account given by M. Carré be true, we have no reason to regret the absence of this system; since it is doubtful whether, under the practice of the ancient searchers of London in the worst days of the plague, when bodies were indiscriminately thrown into large pits soon after death, greater negligence could have been shown than that which is here alleged to have occurred on the part of the French officials in modern times.

Cases have undoubtedly presented themselves in which persons labouring under concussion, syncope, catalepsy, hysteria, or lifelessness from exhaustion, have been pronounced dead by ignorant and uninformed bystanders, merely because there happened to be inanimation, coldness of the surface, and no outward signs of respiration or circulation. If the decision of the question of life or death was always left to such persons, and interments were to follow in a few hours upon their dictation, there is no doubt that living bodies would be exposed to the risk of premature burial. But this can rarely happen in any civilized country of Europe, and then only as the result of gross and culpable neglect. In France the law ordains that every death must be verified by a medical officer; and no interment shall take place until after the lapse of twenty-four hours from the time of death. This rule, it is said, applies only to Paris and some of the chief cities of France. No post-mortem examination should be made, and no interment take place, until after a certificate of death has been issued by the proper medical officer. A similar law prevails in Naples and in Portugal: but Fontenelle states that in the latter country, as well as in Spain, bodies are sometimes interred within *five* or *six* hours after death. In the Protestant parts of Germany and Switzerland, the dead are rarely buried until after the lapse of three days, a period being fixed by law, before which interment cannot take place. In this country there are no legal provisions relative to the period of interment; but, except under severe and continuous epidemics, the dead are rarely buried until after the lapse of from one to five days. It would, no doubt, be a good regulation if every dead body were seen and examined by a medical man twenty-four hours after death, and the fact of death were officially attested by him according to circumstances. The defect of the continental system is, that a medical opinion may be given at any time after the supposed decease, and there may be occasionally great negligence in the performance of this duty. Still it is impossible to admit that, except under the most culpable neglect, persons can

incur the risk of being buried alive, when the body has been kept at least twenty-four hours from the time of the supposed decease. It is stated on the authority of M. Salignac-Fenelon, that in a period of twenty years, during which mortuary houses have been established in Germany, no body has ever been restored to life, although during that time no fewer than 46,000 bodies had been deposited therein ('Ann. d'Hyg.' 1870, 2, 317). Such establishments are therefore not required for this purpose, if ordinary care is employed in making an examination ('Ann. d'Hyg.' 1848, 1, 107).

This statement is fully confirmed by recent investigations in France. (See 'Ann. d'Hyg.' 1867, 1, 293). The results depend not on the establishment of mortuaries, but on the care taken in the attestation of death by the appointed medical officers. The same care given to every case of alleged death, would of course be attended with similar results, whether the dead body is placed in a mortuary or not. When a death has not been properly attested by a medical man, a mistake may be made. A case of this kind, on which M. Devergie has made an elaborate report ('Ann. d'Hyg.' 1870, 2, 310), occurred recently near Morlaix, in France. A woman died, as it was supposed, from cholera. She was seen while ill by a medical man, but not after the supposed death. She was placed in a coffin in an hour, and buried in sixteen hours. During the interment a noise was heard in the coffin. Time was lost in sending for a medical man, and the coffin was not opened until he arrived. The shroud was found twisted and folded about the neck and feet, as if struggles had been made, and there was a quantity of liquid on it, which had issued from the mouth and nostrils during efforts made to breathe. The body was warm and not rigid: there was a general relaxation of the muscles: the hand was translucent to light, and the pulsations of the heart had not completely ceased! Efforts were made to resuscitate the person, but without success. These conditions are consistent with death from cholera, with the exception of the last. If the medical officer was correct in his observation, this person had really been buried alive.

This and other cases were made the subject of a petition to the French Senate in January, 1869, and subsequently remitted to M. Devergie for a report. He convincingly proved that the catastrophe was owing to the non-observance of the law. There had been no medical attestation of death. The relatives were over-anxious to bury the supposed corpse, probably from fear of contagion; and not having any place for the deposit of the body, they were in haste to remove it from the house.

The remedy for an evil of this kind is not to discover some certain sign of death to guide ignorant persons, for it would be always dangerous to give them a power of judging, but to enforce strictly the rule that no body shall be buried except on a medical certificate of death and its cause! Mortuaries would be useful in poor districts for the reception of bodies after verification of death, until interment can take place; but not on the ground that there are no means of determining the reality of death before putrefaction has taken place.

Non-professional persons may readily mistake a state of insensibility for death, and in acting upon this belief, may lead to the death of a living person. Mr. Guthrie mentions the case of a man labouring under concussion, while on board a vessel. He was supposed by his brother and the captain to be dead or dying, and without being able to make any movement to indicate that he was alive and understood their conversation, he heard them discussing the question whether his body should be buried at sea or carried on to Rotterdam. Fortunately the latter alternative was adopted. Dr. Druitt reports two cases of a somewhat similar kind. A gentleman who was most severely affected with cholera in India, told him that when the disease had

gained the complete mastery over him, he lay utterly deprived of speech and motion, whilst he could distinctly hear his attendants, who conceived him to be insensible, speculate on the time of his decease, which they judged to be very near at hand. He then, besides being speechless, became blind and deaf; but although thus cut off from all communication with the external world, and in common language insensible, he still retained his consciousness and self-possession, and reflected on his apparently inevitable death. Afterwards he lost all thought and consciousness, and remained thus on the very threshold of death for some hours; his recovery being an instance of the capriciousness of this terrible disease, which so often sets all medical calculations at defiance, causing the living to appear as if dead, and sometimes imparting to the dead the heat and spontaneous movements of the living body. The other case was that of a boy, æt. 6, the son of a milliner in Regent Street. He had the small-pox, was pronounced dead, and his body was put into a coffin. After some hours, he became conscious, heard the voice of his mother, who sat by the coffin, and he essayed to speak; but, as he afterwards said, he was unable to make any movement or sound to show that he was alive. At last, however, his mother's attention was drawn to some apparent change in the features: she watched him narrowly, perceived the lips to quiver, and soon he was able faintly to articulate a wish for wine ('Ed. Monthly Journal,' April, 1844, p. 355). These two cases have led the reporter to believe in the possibility of the hasty interment of the living as dead, while the unfortunate person is conscious of his condition, but unable to communicate his feelings to others. Mistakes of this kind are not likely to be made by medical men. In order to avoid the possibility of such occurrences, no interment should be allowed to take place until after the lapse of twenty-four hours, at the least, from the time of the supposed death; and not even then, except upon the certificate of a medical practitioner who has examined the body. At present the *cause* of death is certified, and a body cannot be buried except upon the certificate of the registrar; but the medical attendant has it in his power to give this certificate without seeing or examining the body of the deceased at that period after death which is necessary for the clear development of the signs of dissolution. Hence, unless, as it commonly happens, the interment be delayed by the relatives for twenty-four hours at the least, there might be a risk of prematurely consigning a living person to the grave.

During the prevalence of epidemic disease, as in the time of the cholera, a provision was made, that interments should not be delayed beyond twenty-four hours, when death had taken place from the disease. There is no doubt that many bodies were interred during the raging of the epidemic within eight or ten hours after apparent death. One instance was communicated to me where the body was wrapped in a pitched cloth and buried within *six hours* after the signs of life had ceased. This is assuredly a most condemnable practice, especially in cases in which the deceased has not been attended by a medical practitioner. Under no circumstances should a body be buried within a shorter period than twenty-four hours, when death has taken place from chronic disease, or without any obvious and satisfactory cause. No possible mischief can result to the living by the adoption of such a practice; while it would effectually guard against premature interment among the lower classes of society. In assigning twenty-four hours, this is to be taken as an average period; there are cases in which the most striking phenomena of death, such as coldness and rigidity, may manifest themselves within a much shorter time than this, and in such cases a medical opinion may be given without any difficulty. No coroner's inquest should be held upon a body until twenty-four hours after death. I have heard, however, of one instance

in which an inquest was held on a body half an hour only after the apparent cessation of life.

If we allow a proper interval to elapse after the supposed death, there can be no difficulty in solving the question, whether a person is really dead even before any of those changes, which arise from putrefaction, have manifested themselves. The circumstances on which we may rely as furnishing conclusive evidence of death, are the following:—1. The absence of circulation and respiration for at least *an hour*, the stethoscope being employed if necessary; 2. The gradual cooling of the body, the trunk remaining warm while the members are cold; and 3. As the body cools, the gradual supervention of a rigid state of the muscles, successively attacking the limbs and trunk, and ultimately spreading through the whole muscular system.

When these conditions are observed, the proof of death is conclusive; it is unnecessary to wait for any sign of putrefaction. These changes are as certainly the forerunners of putrefaction as the process of putrefaction is itself the forerunner of the entire destruction of the body. I believe it may be safely said that there has not been a single instance of resuscitation after rigidity had once commenced in a body. During the raging of epidemics, if additional evidence be required for early burial, it might be obtained by exposing a superficial muscle to the galvanic stimulus. If the fibres do not contract, death is certain. If they do, this is no proof that the person can be restored to active life; but further time may be allowed before the body is committed to the grave.

So much alarm exists in some continental states relative to premature interments, that there are attached to the cemeteries of some great cities apartments, kept at a high temperature, where the bodies of the recently dead are deposited, and closely watched until putrefaction commences. Assistants are at hand with the necessary apparatus for reviving those who may show any indication of returning life. Such institutions must be regarded as superfluous when ordinary care is taken by the relatives of a deceased person. I have not met with any instance in which a body laid out in them was resuscitated after there had been a proper verification of death. In the following case death was only apparent, but the fact created no difficulty. In December 1830, M. Ancelon was called to see a woman, æt. 34, and was informed on his arrival that she had been dead for more than half-an-hour. On examination, no signs of respiration could be detected, the pulse could not be felt, the skin was livid, the belly soft and flaccid, and the arms and legs were cold. It appeared that the woman had suffered from uterine hæmorrhage up to the time of her supposed death. He removed the contents of the uterus, and at this time a bubble of air was observed to escape from the mouth of the woman. On clearing the uterus, signs of life were gradually manifested by the woman. The respiration, indicated at first by air-bubbles, which succeeded one another on the lips, slowly returned; the circulation was also reestablished. She did not recover her intelligence for three days ('Monthly Jour. Med. Sci.' Oct. 1854, and 'American Jour. Med. Sci.' Jan. 1855, p. 268). This woman was not dead, but in a prolonged syncope from excessive hæmorrhage. Auscultation was not resorted to, or the sounds of the heart might probably have been heard, although the pulse could not be felt.

In a few remarkable cases of an authentic character the process of putrefaction has been considerably retarded, and coldness and rigidity have not manifested themselves in the ordinary course. Such cases of apparent death would necessarily give rise to doubt; the phenomena observed were probably owing to the presence of some traces of molecular life persisting in the body after active life had entirely ceased. One of the most singular of these cases was reported some years since in Hufeland's 'Journal of Practical Medicine.'

A young man, who was a patient in the hospital of Paderborn in Prussia, died, as it was supposed, under symptoms of phthisis, but not of a well-marked character. He had recently recovered from an attack of ague. The cause of death appears to have been obscure, and after, as it was believed, he had expired, his eyes were suddenly opened, and the physicians thought they detected for some minutes an irregular beating of the pulse. Some wounds and cauterizations were made on the body without arousing him, and on the third and fourth days these, it is said, had passed into a state of suppuration. On the fifth day his right hand turned back and closed; from the fifth to the ninth day a clammy perspiration was perceived upon the skin, and some vesicles containing serum were formed on the skin of the back. During this time there was no appearance of respiration or circulation, and the limbs, although cold, were pliant and flexible. The forehead was furrowed with vertical wrinkles, and the countenance had an expression not usually observed in a dead body. On the eighteenth day the lips presented their usual red colour, and although the body was lying during this time in a warm room, there was no disagreeable odour and no cadaveric ecchymosis. On the twentieth day, the signs of putrefaction first became apparent, leaving then no doubt of the reality of death. As a report of this case was published in a medical journal of repute, although the details are imperfectly given, it may be considered authentic. As such, the conclusion to which it leads has already been anticipated. The ordinary signs of death, *i. e.*, slow cooling and progressive rigidity, were not observed. Further, when the body was exposed to conditions favourable to putrefaction, the changes indicative of this process are stated not to have been manifested for a period of twenty days. Such a case was altogether exceptional, and was thus treated by the hospital officials. The body was neither inspected nor buried, but simply watched until death was made certain by the actual occurrence of putrefaction. Had this patient fallen into the hands of ignorant nurses or attendants instead of professional men, it is probable that the body might have been consigned to the grave in two or three days. Although, as the event subsequently proved, this would not have furnished another instance of the premature interment of a living person, yet the proper course in all doubtful cases is to wait until that doubt has been satisfactorily resolved by the appearance of the obvious signs of decomposition.

A case of a somewhat similar nature occurred at Deptford in 1844. A youth died suddenly, and, in consequence of the body showing no signs of decomposition after several days, it was believed by the friends that the deceased was in a trance. The body was seen by several medical men, and they, in spite of some unusual phenomena, came to the conclusion that the youth was really dead. Some days after death the features acquired a natural character, and there was no change indicative of commencing putrefaction. The body retained its general appearance for twenty-eight days; but several medical men who saw it at this period agreed that decomposition had begun. It was not until thirty-five days after death that the friends would allow an inspection to be made, and it was then found that deceased had died from an attack of congestive apoplexy. It was observed at the inspection that, in spite of the long period which had elapsed since death, and the exposure of the body to a warm temperature, putrefaction had made but little progress. In October 1849, a youth died at Bristol from an attack of malignant cholera in about fourteen hours. After the lapse of forty-eight hours, it is stated that the warmth of the body (post-mortem heat) was perceptibly retained, and there was no appearance of decomposition. Some days afterwards, however, the process manifested itself as usual.

Death-trance.—The slow access of putrefaction in certain cases is no doubt the basis of the Wallachian superstition, described by the late Dr. H. Mayo under the name of Vampirism. When dead bodies were disinterred and had apparently undergone but little change, it was believed that they were transformed into vampires, and that they had been nourished and preserved by sucking the blood of the living! As a mere effect of panic, the prevalence of this popular belief led to numerous deaths: those who died were hastily buried: the bodies of suspected persons were disinterred, and if found undecomposed they were either staked or burnt. The late Dr. H. Mayo, in his 'Letters on the Truths contained in Popular Superstitions,' has shown the absurdity of this superstition, but at the same time he has suggested an explanation of the facts, which can only have the effect of creating alarm in reference to the premature interment of the living. He concludes, 'That the bodies which were found in the so-called vampire state, were simply alive in the common way, or had been so for some time subsequently to interment; that, in short, they were the bodies of persons who had been buried alive, and whose life, where it yet lingered, was finally extinguished through the ignorance and barbarity of those who disinterred them.' But for the writer's high rank as a physiologist, such a statement as this would scarcely require notice. He is here referring to the bodies of persons exhumed after having been buried for periods varying from *six* to *twelve weeks*. The hypothesis that these persons had been alive for some time subsequently to their interment, would render it necessary to suppose that this vitality had continued to within a few days of their exhumation, otherwise it would be equally difficult to account for the absence of signs of putrefaction. Death-trance, however, according to Dr. H. Mayo, is a positive status; a period of repose, the duration of which is sometimes definite and predetermined, although unknown. Thus, the term of the death-trance having expired, the patient sometimes suddenly awakes, and is at once restored. 'The basis of death-trance is suspension of the action of the heart, of breathing, and of voluntary motion: generally likewise of feeling and intelligence; and the vegetative changes in the body are suspended. With these phenomena is joined loss of external warmth, so that the usual evidence of life is gone.' It is obvious from this statement, that the writer makes no distinction between life and death. All the ordinary phenomena of life may have ceased, and yet, if from any circumstances the decomposition of the body has been retarded, it may be contended that the person is not dead but simply in a death-trance. Such a startling and incredible hypothesis is wholly unnecessary to explain the facts. If, as in the cases of retarded putrefaction elsewhere related, the bodies are buried within twenty-four hours after death, they will probably remain unchanged in the coffins in a deep grave for a very long period. By the act of interment the bodies are removed from the air, and are maintained at a cool and uniform temperature in the earth. In interments which take place during the winter-season, the bodies, *cæteris paribus*, are only slowly changed by putrefaction. This would constitute the vampyre state, or the death-trance, as it has been accepted by Dr. H. Mayo; but it is simply regarded as death by all physiologists. The entire absence of the ordinary signs of active life is sufficient, according to this physiologist, to prove the absence of life—a proposition which may be granted in reference to a *few hours* of time; but it would be unreasonable to adopt his method of inquiry, and judge of death by the presence of *one* sign only, instead of taking these signs in their totality and ordinary sequence. Premature interment is a condition which need not be dreaded in this country, where due precautions are taken even with the corpse of an unclaimed pauper; and it is to be regretted that otherwise well-informed professional men should strive to keep alive a groundless fear in the

public mind, by their want of attention to the exceptional conditions to which experience shows the process of putrefaction is liable. ('Med. Gazette,' vol. 45, p. 21.)

It may be occasionally difficult to form an opinion of the reality of death n cases of recent drowning or hanging. Coldness and stiffness of the body in the drowned, should not prevent the application of means for the restoration of life. One or two hours may elapse before signs of animation appear, and in one instance a drowned person was not restored until the means of resuscitation had been applied for eight hours and a half. There is reason to believe that some persons removed from water in a state of apparent death are consigned to actual death, owing to want of timely application of the means, and a want of perseverance in the treatment. The continued coldness of the body, and the absence of any evidences of success after a few trials, are commonly taken as sure signs that the person is really dead. There appears, however, to be in some cases a lingering vitality about the body. In an attempt to resuscitate a drowned person who had been five minutes below the water, and was speedily treated after removal, it was observed that the face which had been pale became suddenly livid, and underwent a remarkable change of expression. This appearance, however, was only momentary: continued efforts failed to restore life. In this form of asphyxia, as well as in hanging and suffocation, some caution is required in pronouncing that a person is really dead, since it at once discourages the efforts of those who are employing means for resuscitation. If the body has been for half an hour or longer under water—if it has been found hanging or in a suffocating medium and is cold and rigid—there can be no hope of resuscitation.

In new-born children it is sometimes difficult to say whether life has or has not ceased. M. Brachet has succeeded in restoring children, in whom the heart's action had been suspended from fifteen to twenty minutes. Respiration and circulation are carried on in such a tranquil manner in an apparently lifeless body, that except by the presence of some degree of warmth, and the absence of rigidity, the child might be pronounced dead. Cases are elsewhere recorded in which children have survived birth for six, and even for twenty-four hours in this state of passive life. After death no air was found in the lungs. (See INFANTICIDE.)

CHAPTER 5.

INFERENCE OF THE TIME OF DEATH FROM THE STATE OF THE BODY BEFORE PUTREFACTION—PRIORITY OF DEATH—PRESUMPTIONS OF SUICIDE OR MURDER—OF SURVIVORSHIP—STAGES OF CHANGE AFTER DEATH—CADAVERIC LIVIDITY—SUGILLATION—ECCHYMOSIS.

THE changes which take place in a dead body before the commencement of putrefaction, if accurately observed, may sometimes enable a medical witness to form an opinion of the time at which the deceased died. The dead body of a person may be found in a house with marks of murderous violence upon it; the crime may have been so recently perpetrated, that the body still retains the warmth and pliancy observed in the recently dead, or it may be found in a cold and rigid state. A person charged with the murder may be able to prove that he had not been in the house for many hours, or days; or evidence may be adduced to show that he was there at a time which would correspond to the condition of the body when found. In cases of sudden

death from violence or suspected poisoning, a medical man, by observing the state of the body, may frequently form a judgment of the time at which death occurred, and, therefore, of the period at which poison was taken by deceased, or violence was inflicted on the body.

In the following case of murder and suicide, the murderer was clearly pointed out by the difference in the condition of the two dead bodies when they were first discovered. In March 1836, a man and his wife were found dead in bed, and their bodies were covered with blood, from wounds inflicted on both. In the case of the woman there was a deep incision in the throat, besides a wound under the chin, and another on the side of the head. The man's throat was also severely cut; the razor with which the wounds had been inflicted was found on the bed, within a short distance of his right hand, as if, in the last act of life, he had endeavoured to throw the weapon from him, but had failed in the attempt. The body of the woman was cold and rigid, that of the man was warm. The nature and direction of the wounds, and the marks of violence on the woman's person, were such as to render it probable that she had not committed suicide; and the condition of her body showed that she had been dead many hours. On the other hand, the wound in the man's throat was such, that he could not have long survived its infliction; and as his body, when found, was warm and pliant, it was a reasonable inference that the wife had died first, and from wounds inflicted by her husband, as no other person had access to the house. If the body of the wife had been found warm, while that of the husband was cold and rigid, the inference of his having been her murderer (the wound in her throat being of a nature to produce instant or very speedy death) could not have been sustained. In forming a judgment of priority of death in such cases, the sufficiency of the wound to produce instant or rapid death must always be taken into consideration. A person may inflict on another a slight wound, which may prove fatal by hæmorrhage only after some hours, while he may afterwards inflict upon himself a wound which would instantly destroy life. In such a case, the body of a murderer would be found cold, while that of the victim, by reason of the death being more recent, would be warm. In the case of a woman who was found dead in her apartment, with her throat cut, in November 1847, it was ascertained that, when first discovered, the body was so warm as to render it highly probable that the crime must have been committed within an hour. This observation tended to prove the innocence of a person who was suspected of the murder, because it was known that he had been absent from the house for at least five hours.

In the following case, which is a type of many, the theory of suicide was sustained, and that of homicide completely rebutted, by a medical inference from the condition of the body. In August 1830, the Prince de Condé, or *Duke of Bourbon*, was found dead in his bedroom, in the Château of St. Leu. When discovered, at eight o'clock in the morning, the deceased was found partly undressed, hanging by his cravat to one of the window-shutters. The body was cold and the lower extremities were quite rigid. As in asphyxia from hanging, the warmth of the body is usually preserved longer than under common circumstances, *i.e.*, from twelve to fifteen hours, before which period rigidity is seldom complete, the medical examiners inferred that the deceased must have died very soon after he had retired to his bedroom on the previous night. As this was proved to have been ten o'clock P.M., it followed that only ten hours had elapsed—a short time for cooling and rigidity to have taken place. It was thus rendered medically probable that the hanging took place soon after the deceased had entered his bedroom. It was alleged that the duke had been murdered, and his body afterwards suspended by his murderers to create the suspicion of suicide. The condition of the body, among other circumstances,

was, however, adverse to this presumption. From ten until twelve o'clock at night, it was proved that there were numerous attendants moving about near to the duke's apartments. These persons must have heard any unusual noise, which the duke would probably have made in resisting his assailants. But no noise was heard in the apartment at that or any other time, and the presumption of this being an act of homicide was therefore strongly rebutted. Had the body been found warm and pliant, and the joints flexible, the inference would have been that the deceased had died more recently, and therefore at a time when murder might have been perpetrated without attracting the observation of his attendants. As it was, the coldness and rigidity of the body justified the medical opinion expressed, and tended to prove that this was really an act of suicide.

Criminals sometimes unknowingly furnish important evidence in reference to the condition of the dead body. At the Lewes Autumn Assizes, 1860, a schoolmaster named *Hopley* was convicted of flogging a pupil to death. There was reason to believe that the boy had died during the actual beating. The accused stated before the coroner that he went into deceased's bedroom about six o'clock in the morning, and found deceased dead, his body cold, and his arms stiffening. He suggested that he might have died from natural causes. It was proved that the prisoner was heard in the act of beating deceased up to 11.30 on the previous night; and as the body was cold when found, and rigidity was commencing, there was a strong probability that deceased must have been dead at least six or seven hours, and, therefore, at a time when the prisoner was last known to have been with him. The body was well developed, covered with bedclothes, and the temperature not at the time low.

In the case of *Doidge* (Bodmin Aut. Ass. 1862), who was charged with murder, medical evidence derived from the state of the dead body when found, tended materially to corroborate the circumstantial evidence against the prisoner. The deceased was last seen alive at 10.30 P.M. on the night of the 7th June 1862. He was found the next morning, about 9.30 A.M., dead in his house; he was lying on his face with his clothes on—one arm under the chest, and the other by his side. He had received, on the back of the head, some severe blows, which must have proved speedily fatal. The body when found was quite cold, and the limbs were rigid. It was considered by Mr. Thompson, who saw the body, and by myself, that deceased, under these circumstances, had been dead from eight to ten hours. There was no doubt that this was an act of murder, and that the deceased had been killed while taking off his boots to go to bed. The prisoner was connected with the act by a chain of circumstances. He was seen drinking and conversing on friendly terms with deceased at a beer-shop the evening before. Prisoner left the shop at a quarter past ten, and deceased at half-past ten. They both lived near to the shop and to each other. A neighbour of deceased's, who was out as late as twelve o'clock, heard at that time the voices of two persons in conversation in deceased's kitchen. One of them he recognised as that of the deceased, and the other as the voice of the prisoner, with which he was well acquainted. This witness heard the voices for some minutes, returned into his house, and went to bed. He was soon afterwards suddenly awakened by a noise like that of a heavy fall proceeding from deceased's kitchen, in which the dead body was afterwards found. His evidence was corroborated by that of his wife: hence it is clear that deceased was alive for some time after twelve o'clock that night. It was further proved that, contrary to his usual practice, the prisoner did not return home to his lodging until one o'clock in the morning; and then, in order to account for his return at so late an hour, he made a statement which was proved to be untrue. The coldness and rigidity of the body, therefore, when discovered at

9.30 A.M., considering the season of the year, and the circumstance that deceased was in his clothes, were facts in themselves quite consistent with the occurrence of death soon after twelve o'clock at night, or about the time when a heavy fall was heard by the neighbour. Other circumstances, which were proved, left no reasonable doubt of the prisoner's guilt, and he was convicted.

Perhaps no case has brought the importance of questions of this nature so prominently before the public as that of *Gardner*, a chimney-sweep, who was tried and convicted of the murder of his wife, at the Central Criminal Court, in October 1862. The prisoner lived with his wife and another woman named Humbler. The wife was found dead in her bedroom, with wounds in her throat, at eight o'clock in the morning of the 15th September 1862. The nature and direction of the wounds, the position of the body, and of the weapon, as well as other circumstances, conclusively proved that this was an act of murder; and as there were no persons in the house at the time of the occurrence excepting the woman Humbler (the servant) and the prisoner Gardner, it followed that one or both must have been concerned in the act. Gardner accused the servant, Humbler, of having perpetrated the murder during his absence from home; but as there was no evidence against this woman, he alone was subsequently called upon to answer the charge. The facts, as they bear upon the question which we are now considering, are very simple. Mr. Sequeira saw the body of the deceased, a healthy, well-developed woman, æt. 37, at eight o'clock in the morning. Her body was found lying on a wooden floor, covered with a flannel petticoat and a chemise. The upper limbs were cold and rigid; the face, shoulders, and chest were cold; the neck was so rigidly fixed with the trunk, that the entire body was lifted up with it, when the head and neck were raised; the thighs and legs were quite cold, but there was no rigidity in these parts. The only warmth found about the body was in the lower part of the abdomen; and this obviously arose from the contents of the uterus, the deceased being in the seventh month of pregnancy. The opinion given by Mr. Sequeira regarding the time of death before its exact bearing on the guilt of the prisoner could have been known, was that the deceased had been dead *above four hours*, certainly more than three, and that she could not have been dead so short a time as two or three hours when he first saw the body. This opinion was corroborated at the trial by another medical witness, Mr. Comley, this gentleman affirming that, considering the general coldness of the body, the deceased, when seen at eight o'clock, had been dead above, rather than under, four hours. There was a severe wound on the throat, involving the superior thyroidal artery and other vessels. From this, about two pints of blood had flowed on each side of the neck on the floor. The larynx had been laid open between the thyroid and cricoid cartilages. Blood had flowed into the windpipe through this aperture, and had thus, by obstructing respiration, produced death by asphyxia.

Without going into all those circumstances which tended to fix this crime beyond any reasonable doubt upon the man Gardner, it may be sufficient to state that the defence turned principally upon the condition of the dead body when found. It was proved that from four to eight o'clock in the morning, *i.e.* for about four hours, the prisoner was absent from home, following his usual occupation as a chimney-sweep. It was contended by his counsel, that within this short period the body might have become cold and rigid as it was found, and, therefore, that the murder had been perpetrated by some one during his absence. On this theory the woman Humbler alone was guilty. The facts proved at the trial were, however, considered by the jury to be quite inconsistent with the innocence of the prisoner, and he was convicted of

the crime. The subsequent commutation of the sentence to penal servitude for life, is a proof that the authorities considered that he was the principal if not the sole perpetrator of this crime.

The opinions given by the medical witnesses at the trial, regarding the inference derivable from the state of the dead body, were reasonable, and in accordance with scientific observations. In assigning *four hours* for the almost entire cooling and commencement of rigidity in the dead body of a woman suddenly dying in the prime of life, the body not being exposed to any specially cooling influences, it is obvious that they could not be charged with overstating, but rather with understating, the period of time required. Considering that death had taken place by asphyxia, if they had assigned six or eight hours, it would have been only consistent with ordinary experience. It is, indeed, more probable that this time had actually elapsed, and that the woman had died in from two to four hours before the male prisoner had left the house, than that her body, under the circumstances proved, had become cold and partially rigid in less than four hours. In the hundred cases observed by Dr. Wilks and myself, there was not an instance in which such rapid cooling and access of rigidity occurred. In Mrs. Gardner's case, it was supposed that the loss of blood would account for this state of the body at so early a period after death; but, in the first place, the deceased did not die from hæmorrage, but suffocation; and, secondly, a well-marked case elsewhere related (page 48), shows that the loss of twice as much blood in hæmorrhage proving suddenly fatal, led to no acceleration of cooling or rigidity in the dead body. Irrelevant experiments on animals, and theoretical speculations of an *ex post facto* kind, advanced for a particular object after a conviction for murder, should not be allowed to weigh against opinions deliberately formed and expressed by professional eye-witnesses, who, by their evidence on oath, could have had no intention either to exculpate one person or to inculpate another. As this was clearly a case of murder, and one of two persons must have perpetrated it, the more the charge was removed from the man, against whom there was strong circumstantial evidence, the more completely it would be fixed upon the woman Humbler, against whom there was nothing but an extemporised medical speculation, that a body dead, as it was erroneously assumed, from loss of blood, might become cold and rigid in less than four hours! Had this medical speculation been adopted as true, and acted on *bonâ fide*, it would have exculpated the man, and might have led to the conviction and execution of the woman. It will be easy to show that this speculation, which served its purpose, *pro hâc vice*, of mystifying the medical features of the case, is wholly opposed to the observations of physiologists, who have really studied the changes which take place in the dead body.

As cadaveric rigidity had commenced in the upper part of the body of the deceased when it was first discovered, we may take this as a point of comparison with the actual observations of Nysten and Brown-Séquard. According to Nysten, in cases in which death took place suddenly in healthy persons, either from asphyxia or as a result of hæmorrhage, cadaveric rigidity did not commonly appear until sixteen or eighteen hours after death, and sometimes lasted six or seven days. Brown-Séquard states, that in the bodies of healthy persons decapitated or asphyxiated, cadaveric rigidity did not appear sooner than ten or twelve hours after death ('Proc. Royal Society,' 1861, No. 44, p. 211). Considering these facts, and the circumstances under which this body was found, the assignment of a period of six or eight hours would have been quite within the limits of experience and observation. The medical opinions given at the trial were consistent with ordinary experience, and with the other facts proved in the case.

The case of *Jessie McPherson*, for the murder of whom a woman named

McLachlan was tried at the Glasgow Autumn Circuit, 1862, furnishes an additional proof of the correctness of these views in reference to the bodies of persons found dead from loss of blood. Dr. G. Macleod saw the body of deceased on the night of July 7, when it was first discovered. The mean temperature of the air on that day had been 50°. 'The rigor mortis was present in all the articulations, but it was then departing. The body was perfectly cold, even on the abdomen, and at the flexures of the joints. On the following day, at 10 A.M., the rigidity had gone from all the joints excepting the knees and ankles. There were no signs of decomposition, and the temperature was very cool, unusually so for the season. The room in which the body had lain was well ventilated, but without a draught. It was below the level of the street, and the body lay on a wooden floor, and was partially covered. Further, death had resulted from violence; it had been attended with profuse hæmorrage, and the victim was free from disease, in the prime of life (æt. 35), and of a thin, wiry frame.' Dr. Macleod considering that the rigor mortis commonly appears in from ten hours to three days after death, and that in sudden death from violence it is only slowly developed, thought it most probable that forty-eight hours after death (at the longest) would represent the time when rigidity would appear. 'The more rapidly it is developed, the sooner it disappears, and vice versâ. The average period of disappearance is from twenty-four to thirty-six hours. In the case under review, resting on the same considerations as influenced the opinion formed of the time of the establishment of the stiffening, it was thought that about thirty hours would probably represent the period of the continuance of the rigidity; and by summing these periods—forty-eight and thirty—together, the conclusion was arrived at that about *three days* had probably intervened since death; and it will be remembered that it was afterwards proved that this was, as nearly as could be, the time which had passed between death and the examination of the body.'

'Putrefaction appears on an average under a mean temperature in from three to six days. It is influenced by many circumstances, of which the heat and moisture of the surrounding atmosphere, the obesity and age of the person, the cause of death, the position and coverings of the body, are the chief. In the case of McPherson there was no appearance of decomposition. The cool atmosphere, thin body drained of its blood, the middle age, and thin covering, all opposed its development' ('Account of the Medical Evidence at the Trial of Jessie McLachlan,' by G. H. Macleod, M.D. Glasgow, 1862, p. 8). This medical opinion formed from the state of the body, tended to confirm that part of the prisoner's story which related to the time of death.

On these occasions, unless we have a due regard to all the circumstances of a case, great errors may be committed. We may assign a period for death which is inconsistent with the proved facts, and thus give impunity to murderers. Ollivier and Devergie were once required to examine a medical report by two physicians, in which they stated that they had found the deceased, a woman, aged sixty, dead in her apartment from strangulation. When the body was found it was lying on the floor, clothed in her usual dress of cotton and flannel, in a state of cadaveric rigidity, with general lividity of the surface of the skin. It was cold, with the exception of a slight warmth which remained in the abdominal viscera when the inspection was made. (Les viscères renfermés dans la cavité abdominale ne nous paraissent pas dans un état de refroidissement complet.') From these data the inspectors came to the conclusion that deceased had not been dead more than from fifteen to twenty hours before the time at which they saw the body. This would have fixed the date of the murderous assault at one o'clock P.M.

on March 6, whereas the general evidence tended to show that the crime must have been committed on the night of March 4 or 5.

Considering that the deceased had died from asphyxia, in which case warmth is usually retained, that her body was well clothed, and yet rigid and cold, with the exception of a doubtful trace of warmth in the abdominal viscera, Ollivier and Devergie came to the conclusion that she must have been dead for a longer period than fifteen or twenty hours; and, without defining the precise time, which, under the circumstances, was not necessary, they affirmed that there was no medical ground on which such a restriction of the period of death was justifiable. They contended that cadaveric rigidity, when once established, might remain two, three, or four days, according to the season of the year and other circumstances; and that when it existed, there was no rule by which it could be determined whether the body had been in this state for two or three hours or two or three days (Annales d'Hyg.' 1833, 1, 212). The retention of warmth by the abdominal viscera may be met with after fifteen to twenty hours, in a much more marked degree than in this case. In one case, already referred to in the table (No. 26) published in 'Guy's Hospital Reports,' the temperature of the viscera of the abdomen, more than seventeen hours after death, was found to be 76°, although no care had been taken to preserve the warmth of the body.

These changes in the dead body, may occasionally have an important application to civil suits. When two persons are found dead under similar circumstances, a presumption of survivorship might arise in favour of one, by reason of the condition of the body showing a more recent death. A husband and wife, the latter possessing property in her own right, may be found dead in the same apartment; the body of the husband may be cold and rigid, while that of the wife may be warm and pliant. It might in this case be presumed that the wife had survived the husband, and the heirs of the wife, if she died intestate, might claim her property. On the other hand, if the body of the wife was found in a state of decomposition, while that of the husband was either cooling or in a state of commencing rigidity, there could be no doubt, medically speaking, that the presumption of survivorship lay with the husband, although no human eye may have witnessed the death of either. In this case the few hours' survivorship might be held to transfer the property of the wife to the husband, or through him to the claimants on his part. In these contested cases of presumed survivorship, the litigation between contending parties is often carried to an extreme degree, so that every medical or scientific fact which can be made available, will be brought out on either side.

Some French medical jurists have attempted to give a more definite character to these changes in the recently dead body, by dividing the interval between the permanent cessation of the heart's action and the commencement of putrefaction into three stages or periods. In the first, the warmth and pliancy of the body and muscular irritability remain; in the second, these conditions are lost, and the body is cold and rigid; in the third, the body is cold and pliant, the muscles are relaxed, and the joints are flexible, cadaveric rigidity having entirely ceased. A fourth period is marked by the access of putrefaction, in the appearance of one or more well-known signs indicative of chemical decomposition. There can be no doubt about the existence of these stages, but when we attempt to define the precise time at which they commence and succeed each other, the subject is beset with great difficulty. Thus, according to Devergie, the first stage ranges over a time which cannot be more closely defined than by stating that the person may have been dead from a few minutes to twenty hours! From the

differences observed in different bodies, there would be some danger in fixing these times too strictly; and a medical jurist must be prepared to find that in a question of murder, a counsel who defends a prisoner will reject averages, and take, for the purpose of defence, the longest or shortest period of time within which the respective changes have been known to occur. In spite of this objection to medical evidence, it may be convenient to consider the subject in reference to the three stages or periods proposed by Devergie.

First Period.—This is characterised by the heat of the body being more or less preserved, and by a general or partial relaxation of the voluntary muscles. In such a case as this, after attentively considering the various circumstances special to each, which may have retarded or accelerated the cooling of the body, an inference may be drawn that death has taken place from a *few minutes* to *twenty hours.* These are the extreme limits, and the time will vary according to the degree of heat in the trunk and extremities, and the degree of rigidity in the muscles, as well as in the parts of the body affected, the neck and the jaw commonly showing this condition first and the legs the last. It is rare that the heat of the body is preserved for so long a time as twenty hours; in general it is sensibly cold within ten or twelve, but this estimate will be more or less affected by the condition of the person who makes the observation. During this period, the muscles are susceptible of contraction under the galvanic stimulus, and in the early stage under the mechanical stimulus of blows.

Second Period.—In this the body is perfectly cold throughout, and the cadaveric rigidity is well marked. The muscles are no longer susceptible of contracting under galvanic or mechanical stimuli. In such a case death may have occurred from *ten hours* to *three days.* It is impossible to give a more definite opinion than this, since there are conditions which may develope rigidity, and under which a body may become cold in ten hours or even in a shorter period. In one instance already related, a body was found cold and rigid nine hours after death. Again, there are, as we have seen, other conditions which may prevent the cooling of the body, and delay the occurrence or prevent the disappearance of rigidity for so long a period as three or even four days after death. The duration of this stage from ten hours to three days includes the average cases. Here, again, in forming an opinion we are bound to regard the age, the mode of death, and the circumstances under which the body of the deceased may have been exposed.

Third Period.—The body is perfectly cold: the members and trunk are pliant, and are quite free from any remains of cadaveric rigidity. As this condition has ceased spontaneously, the muscles no longer contract under the influence of the galvanic stimulus. Under these circumstances it may be assumed that the person has been dead from *three to eight days.* In the summer season however this period is much shorter: it will more commonly be found to be the condition of bodies which have been dead from one to three days.

Fourth period.—This commences with the access of putrefaction. It is first manifested by a slight blueish-green discolouration of the skin of the abdomen, and it gradually spreads throughout the body in the manner elsewhere described. Any doubt concerning the reality of death, must cease when the body has reached this stage, at whatever period of time it may manifest itself. Devergie considers this state to represent the condition of the body from *six to twelve days* after death, but the fact is well known that putrefaction may manifest itself on the first or second day, and sometimes as late as the twelfth day after death. These different periods are somewhat arbitrarily selected, and they can be looked upon only as affording approxi-

mative results. During the heat of summer a body may undergo in twenty-four hours all those changes which Devergie assigns to a period of from six to twelve days; while in winter the same changes may not be complete in a shorter period than fifteen days. The power of giving a safe medical opinion, must therefore depend on an accurate observation of the state of the dead body when first seen, and a proper estimation of all the causes which influence or modify the successive changes. Notwithstanding the apparent want of precision which medical evidence necessarily presents in investigations relative to the period at which a person died, yet the cases already related show that approximative results are often of great value. When founded on a correct knowledge of the state of the body, and when they are corroborated by other circumstances, they are received in law with the greatest benefit to the administration of justice.

Cadaveric Lividity and Ecchymosis.—There are certain external changes which take place in a dead body before the access of or during putrefaction, to which it is necessary that a medical jurist should attend. There is what is called *cadaveric lividity*, which comes on during the act of cooling. At a still more advanced period, dark livid spots or patches are met with in the skin, to which the name of *sugillation* or post-mortem ecchymosis has been given. These appearances have often been mistaken for the effects of violence applied during life, and serious mistakes have thence arisen. Innocent persons have been accused of murder or manslaughter, and have been tried on charges afterwards proved to be groundless. Sir R. Christison refers to two cases, in one of which two persons were convicted, and in the other, three narrowly escaped conviction, upon a mistake of this kind.

A man named *Keir* and his mother were tried on the Aberdeen circuit, for the murder of his father. This case excited great interest at the time, and for many years afterwards. The prisoners were condemned, but the only evidence of any weight against them was the appearance of a broad blue mark on the fore part of the neck, which the witnesses compared to that produced by strangulation. There was, however, great reason to believe, from their own description of it, that it was due to natural changes taking place after death. The other case occurred in Edinburgh. Three men left a public-house, intoxicated and quarrelling with each other. On the next morning one of them was found expiring in a wood, and he died soon after he was discovered. Two surgeons deposed, that they found the marks of numerous contusions all over the body; and upon this deposition, the two companions of the deceased were committed, and subsequently tried for the murder. On the trial, Messrs. Bell and Fyfe proved to the satisfaction of the Court, that the apparent contusions were nothing else than the livid patches, which sometimes occur spontaneously on the dead body, after many kinds of natural death. Of course, this led to the liberation of the accused persons.

These spontaneous changes in the dead body must, therefore, be attended to by the surgeon. They may be considered, by dividing them into those which take place *before putrefaction*, and those which take place *afterwards*.

The first form (before putrefaction) is dependent on a stagnation of blood in the capillary vessels. So long as there is life, the capillary circulation continues. This may be ascertained by puncturing the skin or lip with a fine needle; if the capillary circulation is going on, a drop of blood will escape, otherwise not. When after death the capilllaries have lost their contractility, the blood appears to stagnate in them in an irregular manner, producing *lividity*. The skin of the body, although pale at the time of death, becomes covered during the act of cooling by extensive patches of a blueish or slate colour, diffusing themselves over the greater part of the trunk

and limbs. The colour is sometimes of a deep purple, often mottled, but generally abruptly terminating in the white skin. This kind of ecchymosis is chiefly seen on the bodies of those who have died suddenly in full health, or by a violent death, as in apoplexy, hanging, drowning, suffocation from charcoal vapour, and other causes. In the latter case, it has been found in some instances to be especially developed. It is rarely seen in the bodies of those who have died from loss of blood; the skin is in these cases commonly pallid. When the skin in which the lividity is seated is divided, it is seen that the colour is confined to the upper layer of the true skin (cutis), or to the space between the cuticle and cutis, and never to extend through the latter. There is no sanguineous effusion, but apparently a simple congestion in the minute capillary vessels.

The unruffled state of the cuticle, the great apparent extent of the discoloration, the fact that it affects many parts of the trunk and members, and often entirely envelopes the whole circumference of one or both limbs, are, together with its abrupt termination, and the absence of extravasated blood in the cellular membrane beneath, circumstances sufficient to distinguish it from the ecchymosis produced by violence.

Sometimes this lividity is disposed in a peculiar form over the body. If a stout and muscular person has died suddenly, and the body, wrapped closely in a sheet is allowed to cool, the lividity may be sometimes disposed in the form of a number of stripes or bands over the whole surface—the congestion of the vessels taking place in the interstices of the folds, while the parts actually compressed remain white. The appearance of the body is such that we can hardly divest our minds of the idea that the person must have been flogged. The unbroken state of the cuticle, with the other characters just now mentioned, are, however, sufficient to distinguish this appearance from the effects of violence. This kind of lividity is known under the name of *vibices*. It is often seen on the backs of subjects that have been allowed to cool either in their clothes or on any rough and uneven surfaces. A few years since I saw a well-marked case of vibices, in which the suspicion was so strong that violence had been used to the deceased, that a coroner's inquest took place. The fore part of the body was covered with stripes, which were of a red and livid colour: they appeared to correspond exactly to the folds of a sheet drawn tightly across the chest; and it was subsequently ascertained that the body of the deceased had been treated in this manner soon after death. The blood was superficially diffused, and the cuticle uninjured. The circumstance above mentioned at once satisfactorily explained the cause of the appearance. These vibices or weals, like the cadaveric lividity already described, are commonly seen in plethoric persons; they indicate great vigour of circulation at the moment of death. But lividity in the dead body may occasionally present itself under a more deceptive form than in either of the instances just mentioned. This is well shown in the case of a man who died in November, 1837, on board of the Dreadnought hospital ship. The subject of this case, æt. 33, died suddenly from disease of the heart. Just before death the deceased had been ausculated, and no marks then existed on the skin. The body, after about eighteen hours, was examined, and then it was found to present, in detached places, patches of discolouration or ecchymosis, varying in size from small spots to several inches in diameter. Although closely simulating bruises or marks of violence during life, a slight examination showed that they were owing to simple lividity, because those parts of the back and limbs which were not compressed by the surface on which the body of the deceased was lying, were the only parts discoloured. The calves of the legs, the loins, and the back, which bore the pressure, were white. On cutting into these patches, the layers of the skin, as well as the

tissues beneath, were throughout reddened by congested blood, and small rounded semi-coagulated masses oozed out from the cellular membrane on slight pressure.

These characters somewhat resembled those produced by violence on the living body; but there was another, and, I believe, an unexampled circumstance, in which the resemblance to *vital* ecchymosis existed. Around many of the patches there was a wide border, or zone, of a pale straw colour, with various shades of green and blue, precisely similar to those which are seen in the gradual disappearance of an ecchymosis from the living body. By most medical jurists it has been hitherto considered that the zones of colour are peculiar to vital ecchymosis, and are never seen in the ecchymosis produced after death. The occurrence of this case shows with what caution general rules should be framed for medico-legal practice. Had the body of this person been found lying dead and exposed on a high road, and had it been proved that another man had been seen quarrelling with him, what might have been the opinion expressed? We can scarcely hesitate to say, unfavourable to the accused person. This kind of ecchymosis could have been distinguished from that of violence during life only by the unruffled state of the skin, and the slight effusion of blood, compared with the extent of discoloured surface. It is worthy of note, also, that the chief seat of ecchymosis was in those parts which were recumbent or depending. The formation of the coloured zones around some of the patches of lividity was fully explained by the fact of the man having laboured under general dropsy. The serum effused in the cells, here acted upon and diluted the liquid blood, as it exuded from the vessels and diffused it around, much in the same manner as the serous exhalation of the cellular membrane acts on the blood effused in the living body.

A question, connected with lividity, or cadaveric ecchymosis, was raised on the trial of *Reid* (p. 71), namely:—Whether this cadaveric lividity always *preceded* cadaveric rigidity or not? Rigidity is not in general strongly manifested until the body is cold; the lividity here described takes place while the body is cooling and the blood is liquid. The occurrence of rigidity depends on the time at which muscular irritability is entirely lost: but post-mortem discolouration of the skin is closely connected with the presence of warmth in the body, and with fluidity of the blood; hence cadaveric lividity begins to develope itself often soon after death, and continues to increase until the body is cold, when its formation is entirely arrested. It appears to consist simply in a congestion of the capillary vessels, and is produced before the coagulation of the blood in the first stage or period after death. As it has now been clearly proved that rigidity affects the heart and coats of the arteries before rigidity of the voluntary muscles manifests itself, it is highly probable that in the contraction of these tubes, the blood is forced at first through the capillaries into the venous system, and afterwards, from want of sufficient power of propulsion, it stagnates unequally in these vessels, producing livid patches on the skin: although the arteries are relaxed and become quite flaccid, the blood remains in the minute vessels in which it has collected.

Another form of ecchymosis observed in the dead body, is that which occurs some time after death. This appears to proceed from an infiltration of blood into the depending parts of the body, and to be a result of incipient putrefaction. They who are much engaged in inspections are well aware that the skin of the back, especially that covering the loins and buttocks, often presents irregular discolourations resembling ecchymosis. The skin of the back of the head and nape of the neck is a well-known seat of this form of ecchymosis. On cutting into the skin of any of these parts, it is found to be more or less discoloured throughout, and the fatty tissue is filled with a

bloody serum, which readily escapes. In proportion as putrefaction advances, the discolouration becomes greater, passing from a dark red to a green colour. The general characters of this kind of ecchymosis are so well marked, that it cannot easily be confounded with the ecchymosis of violence. The parts of the body in which it is known to occur, as well as the state of the body, are circumstances which distinguish it from all the other forms described. This variety of ecchymosis is also termed sugillation by some medical jurists. (On the subject of Ecchymosis, see 'Ann. d'Hyg.' 1838, 2, 383.)

CHAPTER 6.

PUTREFACTION—ITS NATURE AND PROGRESS—PRODUCTION OF GASES—POST-MORTEM HÆMORRHAGE—PRESSURE ON THE VISCERA—NATURE OF THE GASES OF PUTREFACTION—CHANGES IN THE COLOUR OF THE SKIN AND OTHER ORGANS—PUTREFACTION IN AIR—CONDITIONS FOR THE PROCESS—CIRCUMSTANCES WHICH MODIFY IT—INFLUENCE OF DISEASE AND CERTAIN POISONS—PUTREFACTION IN BODIES BURIED IN GRAVES—PRODUCTION OF ADIPOCERE—ITS CHEMICAL NATURE.

PUTREFACTION.—By putrefaction, we are to understand those chemical changes which spontaneously take place in dead animal matter, during which offensive gases are evolved. The ultimate effect of these changes is, after a longer or shorter period, to reduce the organic to the condition of inorganic compounds consisting chiefly of water, ammonia, and carbonic acid. It is in the stage of transition that noxious effluvia are evolved from which the process derives its name. These consist of compounds of nitrogen, sulphur, phosphorus, and carbon with hydrogen.

This process does not begin to manifest itself in the dead body until after the cessation of cadaveric rigidity, and generally about the third day. It is then observed, if the body has been exposed to the atmosphere in an apartment of mean temperature (60°), that the limbs and trunk become supple and pliant, and yield a faint odour. The skin covering the abdomen becomes of a pale green colour, which gradually deepens. A similar discoloration slowly makes its appearance in the chest, between the ribs, in the face, the neck, the legs, and lastly, in the arms. The colour appears to depend on the decomposition and infiltration of the animal fluids, especially the blood, into the skin. In the neck and limbs it is observed to be more marked in the situation of the large venous trunks; and sometimes, indeed, the course of the superficial veins is accurately traced out by greenish-blue or dark lines; these have been mistaken for marks of violence. This change in the colour of the blood infiltrated into the tissues is probably owing to the action of ammonia as a result of decomposition, on the red colouring matter. In a more advanced state we have found the blood to contain sulphuretted hydrogen as well as ammonia in the form of sulphide of ammonium and carbonate of ammonia. Its colour is then dark brown, almost black, and it effervesces strongly when an acid is added to it. Gaseous products are formed, not only in the hollow organs of the abdomen, but beneath the skin generally; so that on making an incision, the edges of the skin are rapidly forced apart or everted. The reaction of this confined gas accounts for the occasional escape of alimentary and fæcal matter from the outlets:—as also for the escape of blood some days after death from wounds involving any of the large veins.

This *post-mortem hæmorrhage* requires one or two remarks. Its occur-

rence formerly gave rise to the most superstitious notions, and even in the present day an undue importance may be attached to it by a coroner's jury. In order to explain this, and some other apparently vital phenomena connected with a dead body, it will be necessary to refer to those spontaneous changes which commence soon after death. When a person has died suddenly from violence or convulsive disease, it may happen that within a short period the whole of the cavities, including the veins, arteries, and cellular tissue beneath the skin, become distended with gases derived from putrefaction. The gases collected in the abdomen push back the diaphragm, in consequence of which, mucus with air-bubbles issue from the mouth and nostrils; the face is swollen, and the eyes are bright and prominent, owing to the blood having been forced back to the head and neck, by the distended state of the abdomen and viscera. For a similar reason the contents of the stomach are sometimes discharged, escaping into the windpipe, or flowing externally by the mouth and nostrils. That which, however, more immediately concerns us at the present time, is the development of these gases within the heart and large blood-vessels, in consequence of which blood may be forced out of a wound made before death, long after all the phenomena of life have entirely ceased. If an attempt has been made to bleed a person immediately before death, without success, and the operator has neglected to secure the opening in the vessel, it may happen some hours after death, that a large quantity of blood will escape by the wound—conveying to those, who are uninformed on these matters, the idea that the person had again come to life, but had died from the bleeding. An accident of this kind gave rise to considerable discussion, on the occasion of an inquest held at Oldham, on the body of *John Lees*, killed in the Manchester riots, as also in the case of the Crown Prince of Sweden, who was supposed to have been poisoned. A similar flow of blood may take place from a large incised wound, made recently before death. This post-mortem hæmorrhage is facilitated by pressure, and on this was based that ancient test of guilt: viz., the touch of the murderer.

Post-mortem hæmorrhage may take place from wounds made after death, and quite irrespective of putrefaction. If the blood is warm and fluid it may ooze from an open wound in the body and partially coagulate after its escape (see 'Observations,' by Dr. Wilks, p. 64). The quantity which thus flows from a recently dead body is not large, unless some large veins are implicated. Even some hours after death, when the body is cold, bleeding may take place from a post-mortem wound, and might give rise to a suspicion of criminal violence. Mr. Gibson, the surgeon of Newgate, communicated to me the following case which occurred in that prison in July 1871. A prisoner hanged himself in his cell before the door. A warder who found him thus suspended passed his arm through the opening of the door and cut the ligature. The body fell forwards on the floor. It was soon afterwards dragged to the further end of the cell. The body was then cold and becoming rigid. It was found that where the head had rested there was a small pool of blood (about six or eight drachms), and the floor was smeared along which the head had been dragged. The blood was of a bright colour, but there was no separation into clot and serum. On examining the head, Mr. Gibson found a scalp wound about an inch and a half long at the junction of the occipital with the parietal bone. The wound was not regular but somewhat jagged, and there was no effusion on its edges. The wound had been produced, and the bleeding from it had obviously taken place, after death.

When putrefaction has commenced, and there is no open wound from which blood can escape, the cavities of the heart may suffer compression from the gases generated within the chest and abdomen, and a portion of the blood may be thus forced out of them. If full at the time of death, and the body

is examined within a week, it is not probable that the cavities would be completely emptied. If the heart is found empty, and at the same time contracted, its emptiness cannot be assigned to the effects of putrefaction; it was most probably the natural condition of the organ at the time of death. A collapsed and empty condition of the lungs has been ascribed to pressure from the gases of putrefaction, the medical assumption being that they had contained air and blood at the time of death. This is not in accordance with my observation. In advanced putrefaction these organs have also contained gaseous matter and dark-coloured liquid blood. In examining putrefied bodies in cases in which death has been alleged to have been caused by some form of asphyxia, *i.e.* strangulation or suffocation, it will be important for the medical witness to bear in mind these conditions of the heart and lungs. The organs may be found empty and collapsed; in such a case, he must not be too ready to assume, in order to reconcile this condition with the foregone conclusion of a violent cause of death, that they were full of blood or congested at the time of death, and that their emptiness is owing to post-mortem changes. It may be equally probable that they were empty when the person died, for emptiness of the heart and a collapsed state of the lungs are frequently found in bodies which are not putrefied: hence the medical opinion in a given case can be only an inference or surmise. Orfila has observed blood in the cavities of the heart as well as in the lungs of exhumed bodies which had been for some time buried, the organs having a blueish slate colour ('Médecine Légale,' 4 ed. 1, 642). In some instances the gases have had sufficient force to expel the fœtus from the uterus when the woman has died during labour and undelivered. I have elsewhere reported a case of this kind which was the subject of a coroner's inquest at Sydney, in 1864. ('Guy's Hosp. Reports,' 1864, 3rd series, vol. x. p. 253.)

The gases generated in the cavities of the head and face by putrefaction, appear to meet with the greatest resistance to their escape. The features become generally swollen or bloated, one or both eyes may be protruded, the eyelids swollen and dark-coloured, the lips swollen and the tongue protruded between them, gaseous matter with fluid escaping in bubbles from the mouth and nostrils. As the skin of the face is generally livid or even black, it is impossible, under these circumstances, to recognize a person. In death from drowning, when the body is afterwards exposed to a warm atmosphere, the gases of putrefaction are so copiously produced, that the head appears much larger than natural, and the skin of the trunk and limbs is distended with gas, giving to the whole of the discoloured body a bloated appearance.

Gases of Putrefaction.—The *gases* produced in the dead body are in the early stages chiefly ammonia and sulphuretted hydrogen, and at a later period carbonic acid, carbonate of ammonia, nitrogen, carburetted hydrogen, and phosphuretted hydrogen. The nature and quantity of these gases depend more on the degree of putrefaction than on the time which has elapsed since death. The sulphuretted hydrogen may be detected by paper moistened with a solution of acetate of lead; the phosphuretted hydrogen, by paper impregnated with nitrate of silver; ammonia, by the vapour of hydrochloric acid, or red litmus paper; and the carburetted hydrogen, by its combustibility and by the products of its combustion. It will generally be found that the sulphuretted hydrogen is combined with ammonia, since paper impregnated with a solution of nitroprusside of sodium acquires a crimson colour when held in a jar containing the decomposed viscera. Other gases and vapours, of which chemistry can at present render no account, are also present. On some occasions the exhalations have been of a most offensive and nauseous character, and the tests have not indicated the presence of either sulphuretted or phosphuretted hydrogen.

Dr. W. Lewis examined and reported on the external condition and appearance of 22,000 coffins accumulated in the vaults of London churches. He examined the state of the contents of about one hundred of these. The experiments were made on the bodies of persons of all ages, and on coffins which had been deposited for a short period or for upwards of a century. He did not find therein sulphuretted, phosphuretted, or carburetted hydrogen, or any compound of cyanogen. The gases which he uniformly detected in the coffins and the vaults were nitrogen, carbonic acid, and atmospheric air holding putrescent animal matter in suspension. Ammonia was occasionally found in large quantities; this, when present, overcame all other odours. When absent, the animal matter had a smell resembling that of putrid moist cheese. He opened one leaden coffin, in which the corpse had been enclosed for nearly a century; the ammoniacal gas which escaped from it formed dense white fumes when brought into contact with hydrochloric acid gas. It was so powerful that the head could not remain near it for more than a few seconds at a time ('Amer. Jour. Med. Sc.' Jan. 1852, p. 275). I have noticed the same results in reference to a body which was exhumed after six months' interment. When the coffin lid was removed by the side of the grave, a large quantity of fœtid ammonia escaped. On throwing into the coffin some chloride of lime, dense white clouds of the hydrochlorate of ammonia were evolved from the interior of the coffin, to the great alarm of some of the bystanders, who were not aware of the chemical changes produced. It would appear that the air enclosed in coffins is in general completely deoxidized. When tested it was not inflammable, but was found in every instance to extinguish flame. In leaden coffins putrefaction is so much retarded, that the remains of bodies were found in them after the lapse of a century. The metal is slowly corroded and changed into carbonate of lead.

Changes in the Viscera.—During these changes in the dead body, various discolourations take place on the mucous surface of the stomach and bowels, which often closely simulate the effects of disease or poison. The mucous membrane of the stomach may be found of various tints—from a red brown, becoming of a brighter red by exposure to the air, to a deep livid purple or slate colour, and sometimes black from a decomposition of the blood. At the greater end, where the stomach is in contact with the spleen or liver, the lividity is often well marked and clearly defined through all the coats. The peritoneal or outer coat is of a greenish hue, and the course of the superficial vessels is marked by greenish-brown or black lines. These spontaneous changes, which are the result of putrefaction, may be easily mistaken for the effects of irritant poisoning. There are no rules that I am aware of, which will always enable a medical jurist to distinguish such cases. Much must depend on the progress of putrefaction, and the period after death at which the body is examined: hence, each case must be judged by the circumstances which attend it. We may presume that the redness has taken place during life, and is not a result of post-mortem changes. 1. When it is seen soon after death. 2. When it is met with in parts not dependent, nor in contact with other organs gorged with blood. 3. When it is accompanied by a considerable effusion of coagulated blood, mucus or flakes of membrane, the result of ulceration, corrosion, or destruction of the coats of the viscera. When the body is not inspected until a long period after death, it is difficult to distinguish these pseudo-morbid appearances from those depending on the action of irritant poison. In a really doubtful case it is therefore better to withhold an opinion, than to express one which must be purely conjectural.

It is impossible to assign a definite period to which the effects produced by irritant poisons are destroyed by the process of putrefaction. If the poison

were of an antiseptic character, and the body had been speedily buried, a decided redness of the stomach, as a result of inflammation, may be perceived after five or six weeks. On one occasion I was able to distinguish the effects of arsenic on the mucous membrane of the stomach in the case of a child whose body had been interred for a period of twenty-eight days; and in other cases in which the viscera were well preserved, after a year and nineteen months. Of course, when the inflammation is only slight, it will be much more speedily obliterated, or merge in the redness caused by decomposition.

The effects of gravitation in leading to a discolouration of the stomach and bowels in the recently-dead body, should not be overlooked. The experiments of MM. Trousseau and Rigot have determined, that the simple effects of gravitation will produce a livid or even a red appearance of all the dependent portions of the intestines. This *cadaveric congestion*, as it may be termed, has been long known to exist in the lungs; but it does not appear to have attracted sufficiently the attention of pathologists, in respect to the stomach and intestines. It has been especially remarked by Andral and others, in the small intestines, particularly in those portions found within the cavity of the pelvis; and this last-mentioned pathologist noticed, that in a body placed with the face downwards soon after death, the anterior wall of the stomach became strongly reddened. As this effect of gravitation ceases so soon as the blood coagulates by the cooling of the body, so does it follow that when the body has been a long time in cooling, it will be much more strongly marked.

The mucous membrane of the stomach and upper part of the small intestines often presents, during putrefaction, a yellowish or green tinge, depending on the transudation of the bile, or the colouring matter of the fæces contained in the colon. This must not be mistaken for the appearance of poisoning by the mineral acids. There is, in these cases, no softening or corrosion, and the throat and gullet are not implicated, as they are in this form of poisoning. So, again, melanosis in the stomach—*i.e.* a deposit of black colouring matter beneath the mucous coat, might be mistaken for the effect of sulphuric or oxalic acid or caustic alkalies; but melanosis is unaccompanied by any marks of inflammation, corrosion, or destruction in the mucous membrane beneath, and it is always seen in well-defined spots.

Among the *external* changes produced by incipient putrefaction, a change of colour in the skin covering the abdomen, has been already noticed. It slowly acquires a pale green hue, gradually deepening and extending to the skin of the chest and limbs. This colour has been regarded, by M. Deschamps, as a certain sign of death, and one better fitted than any other to guide us in determining the reality of death. This sign, however, is not available, under common circumstances, until three days after death, and it is scarcely possible that a well-informed practitioner should require to wait so long a time before expressing an opinion. M. Deschamps has laid down the following rules respecting this green colour acquired by the skin of the abdomen:—1. A greenish-blue colour, extending uniformly over the skin of the belly, is the only real and certain sign of death. 2. The time at which this sign appears after death, varies much; but it commonly takes place in about *three days*, under favourable conditions of warmth and moisture. 3. Although discolouration of various kinds and from various causes, may occur in other parts of the body, this characteristic mark of death is always to be found in the abdomen. 4. Apparent death can no longer be confounded with real death, the abdomen never becoming coloured green or blue in any case in which death is only apparent. 5. This colouring of the abdomen, the appearance of which may be artificially hastened by exposing the body to a

warm temperature, will, if observed, entirely prevent the possibility of premature interment. 6. There is no danger to public health from keeping a body until the appearance of this characteristic sign of death.

There are some facts connected with the progress of putrefaction as it takes place in the atmosphere, in the earth, or under water, which are of interest to a medical jurist.

1. PUTREFACTION IN AIR.—Putrefaction cannot take place in the *living* body; it is in resisting the access of this process, that the power of *life* or vital force is chiefly manifested. Some have conceived that putrefaction might begin under a diminished state of vitality, as when a person is about to perish from a slow and wasting disease: they have thus explained the peculiar odour perceptible in the breath and perspiration of many dying individuals, some hours previous to dissolution. But it is probable that these exhalations are themselves of a morbid nature: at any rate, it is certain that so long as *life* remains, no phenomena resembling those of ordinary putrefaction in the dead body are observable. It is unnecessary to make any remark in this place relative to local gangrene; since, although this may take place in a living body, it is only observed in a part already deprived of life, and does not involve the whole of the body. It is molecular or partial death.

In some cases, before dissolution, the breath has been observed to be luminous: this has been ascribed to the evolution of phosphorus, which is said to have been distinctly recognized by its peculiar odour. It would appear also, from good authority, that the countenance of a dying person has, on more than one occasion, become distinctly luminous or phosphorescent in the dark. The cause of this phenomenon is unknown, and so far as I am aware it has been only in advanced cases of consumption or wasting disease, that this evolution of light from the countenance shortly before death, has been observed (see cases by Sir H. Marsh, 'Edinburgh Med. Journal' vol. 58, p. 497; and by Drs. Donovan and Stokes, 'Dublin Med. Press,' January 15, 1840). Dr. H. M'Cormack has reported the case of a child, aged sixteen months, suffering from dentition, in which the skin of the hips was observed to be luminous. There was no odour of phosphorus, and no application which could account for it, had been made to the skin ('Ed. Med. Jour.' vol. 66, p. 285). The dead human body may become luminous under incipient decomposition. A remarkable case of this kind occurred in 1823–4, in the dissecting-room of the Webb Street School of Anatomy. The greater part of a dead body which had been dissected appeared luminous or phosphorescent in the dark. The cause of this evolution of light in the dying and dead, is not well ascertained: in the dying it may possibly be owing to certain chemical changes analogous to decomposition, commencing during life; while, in the dead, it may be due to the production of luminous matter of a phosphorescent nature. It is well known that certain kinds of dead fish and decayed wood become luminous in the dark. These singular facts, which have only been observed of late years, will account for many of the superstitions which formerly existed.

The time after death at which putrefaction commences, may vary from a few hours to many days and even weeks. It never begins until cadaveric rigidity has ceased, and therefore not until the muscles of the body have entirely lost their irritability. Whatever conditions of the body during life or after death may operate to cause the disappearance of muscular irritability, will *pari passu* accelerate rigidity and putrefaction, and *vice versâ*. There are three primary conditions which are indispensable to the establishment of this process in a dead body. These are: 1st, a certain temperature; 2nd, the presence of moisture; and 3rd, the free access of air. There are many other conditions of a secondary kind which may retard or accelerate its com-

mencement, and, when established, may affect its progress and duration. These will be considered in their order.

Temperature.—The process is found to go on most favourably in a temperature varying from 70° to 100°. It will commence, other circumstances concurring, at any temperature above 50°; but at 32° it appears to be wholly arrested. The dead body may thus be preserved a considerable time in snow, ice, or in a frozen soil; but if, after removal, it is exposed to a temperature between 70° and 100°, the ordinary putrefactive changes are stated to take place with more than their usual rapidity. Adolph Erman states that the body of Prince Menchikof, one of the favourites of Peter I., was exhumed at Beresov, in 1821, after a burial of ninety-two years in the frozen soil of Siberia. Although so long a time had elapsed, the body had undergone but little change. The heart and some other parts, with a portion of the grave-clothes, were removed and sent to the descendants of the deceased ('Travels in Siberia,' vol. 1, p. 462). But a still more remarkable instance of the preservative or antiseptic power of cold, is exhibited in the discovery of the body of an ancient elephant (*elephas primigenius*) in a mass of ice at the mouth of the River Lena in Siberia in 1805 ('Quart. Journ. of Science,' vol. 8, p. 95). Some years since I saw a portion of the dried skin and long hair of this animal, the race of which was extinct before the historical period.

A low temperature is said to arrest putrefaction by congealing the moisture within the animal body; but this explanation is not of itself sufficient, since a body at 33°, has no more tendency to putrefy than one at or below 32°. The true reason seems to be, that heat is essential to the combination of the gaseous elements of the body during putrefaction, as well as to the existence of the gaseous products resulting from their union. At a high temperature, again, *i. e.* about 212°, putrefaction is arrested. The soft animal solids lose their water, become hard and brittle masses, and may now be exposed to the atmosphere without undergoing any further change. A heat between 100° and 212° may also speedily put a stop to the process, by causing a rapid evaporation of the water contained within the solids. They become thereby dried and coagulated. Thus it is that bodies buried in the hot and arid sands of Egypt are dug up, many years after interment, in the state of dessiccated mummies, putrefactive decomposition having been long since arrested. The effect of temperature on this process is strikingly seen in the influence of season. A dead body exposed to air during summer, when the thermometer is above 60° or 70°, may undergo more marked putrefactive changes in twenty-four hours, than a similar body exposed for a week or ten days in winter. This is a fact which demands consideration, when an opinion is required to be formed, respecting the date of death of a body concerning which nothing is known.

Light has not been found to have any influence over the process.

The presence of moisture.—Unless the animal substance is impregnated with water or moisture, it is impossible that putrefaction can take place. The animal solids commonly contain sufficient water for the spontaneous establishment of the process. In a human body weighing 150 lbs., there are about 100 lbs. of water ('Brande and Taylor's Chemistry,' p. 831). The soft organs differ much from each other in respect to the quantity of liquid contained in them, and therefore in the degree in which they are prone to putrefaction. Thus the brain and the eye are in this respect contrasted with the teeth, bones, hair, and nails. The fluids of the eye are rapidly decomposed, while the teeth and hair may remain for centuries unchanged. The late Mr. Quekett examined a portion of dried human skin with hair upon it, which had been exposed for many centuries on a door of Worcester Cathedral, and

also other portions taken from the church doors of Hadstock and Copford in Essex. He found upon them some hairs, which were proved by the microscope to be human, thus confirming the old tradition that the skins of persons who had committed sacrilege were nailed to the doors of the churches which they had robbed ('Edinburgh Monthly Journal,' July, 1848, p. 63).

If the organic substance is deprived of its water by any means, putrefaction is arrested. Gay-Lussac found that flesh might be preserved for a considerable period, simply by suspending it under a bell-glass, placed in a dish of fused chloride of calcium. Albumen and gelatin, deprived of water, or dried by chloride of calcium, have been kept in a dry state for a period of twenty years, during which time they have been exposed to air and a favourable temperature, without undergoing putrefaction. An excess of water, however, tends to retard and modify the process: thus, by allowing a current of water to fall on animal matter, it may be preserved for a length of time. Water appears to act in putrefaction as it does in numerous other chemical processes, by its dissolving power. It brings the minute atoms of organic substances within the sphere of their mutual attraction. In excess it seems to retard putrefaction by merely cutting off the access of air. By long contact it produces an alteration in the soft solids, converting them into a white substance.

Influence of Air.—Putrefaction may take place to a slight extent independently of air, but the process is soon arrested; and thus bodies sealed permanently in leaden coffins, are found perfect and may be identified after very long periods of time. The products in all cases in which air is excluded, are chiefly of an ammoniacal nature. Air operates by its free oxygen combining with the animal elements, and forming gaseous and liquid products. The only limit to this process of decomposition under a free supply of oxygen, is the loss of water by evaporation. Nitrogen, the other element of air, has no influence; it appears to be decidedly antiseptic, so that flesh may be preserved in it for a very long period without change, although heat and moisture are present.

In gaseous mixtures it is necessary to putrefaction that the oxygen should be *free* as in the atmosphere, and not chemically united to any other element. Thus carbonic acid and nitric oxide, especially the latter, since it will not admit of the approach of free oxygen, act as most powerful antiseptics. In a series of experiments on the properties of these gases in retarding putrefaction, I found in one that a large piece of fresh muscle was preserved effectually in a bell-glass of nitric oxide over water for eighteen weeks; in a second experiment, for nineteen weeks; in a third, performed in 1842, for a period of thirty-two weeks, or 224 days; and in a fourth, for a period of seventeen months. The last experiment was commenced in October 1862, and in March 1864 the muscle suspended in the gas retained its red colour, and although eighteen months had elapsed it had undergone no change indicative of putrefaction. These experiments were carried on under all variations of temperature, in a room not below 40° in the winter season, but which sometimes reached 80° in summer. As the vessel containing the gas was placed over water, the gas was of course always saturated with aqueous vapour. Two of the conditions for putrefaction were therefore present. Air only was removed. In some parallel experiments in air and oxygen, putrefaction had gone on to a full extent in eight or ten days. These facts show that oxygen in a free state, is eminently necessary for the destruction of the soft parts of the body by putrefaction.

The influence of the atmosphere is not merely confined to its affording oxygen. It modifies putrefaction, according to its dry or humid condition,

and according to its state of rest or motion. Dry air retards putrefaction, since evaporation is increased. Humid air accelerates the process, by giving rise to an opposite effect. Air in motion, as a brisk wind, retards the process, since, *cæteris paribus*, evaporation is greater. Air at rest, as the calm still atmosphere of a close apartment, is, on the other hand, favourable to the process. On the whole it may be inferred that the conditions most favourable to the putrefaction of a dead body, are a temperature of about 70° in a humid and tranquil atmosphere. It has been observed that when putrefaction has once begun in a part of the body, it has rapidly extended itself throughout the whole. It seems as if the first products acted as a kind of ferment, to induce chemical changes throughout the mass.

Modifying Conditions.—There are some circumstances which modify the progress and duration of the process. They chiefly relate to the condition of the body at the time of death. Orfila thought that age and sex, as well as peculiarity of constitution, had some influence, but there are no facts to confirm this view.

Fat and flabby bodies are observed to undergo putrefaction more readily than those which are thin and emaciated. This probably depends on the greater quantity of blood contained in them. Connected with the state of the body, we may also mention the influence which wounds or bruises, or mutilations of any kind, have over this process. Those parts which at the time of death are affected by contused or incised wounds, ecchymosis or extravasation, rapidly pass into a state of putrefaction. Thus, in examining bodies which have been subjected to violence during life, contusions and ecchymoses may appear greatly aggravated in extent, unless the examiner be aware that such parts become more speedily decomposed.

The bodies of persons who have died from acute diseases, have been observed to putrefy more readily than those of persons who have died from wasting and chronic disease. In the numerous examinations of the dead made at Guy's Hospital by Dr. Wilks, he observed as a rule, that the bodies of those who had been long ill, and were emaciated, remained unchanged for a longer time than those who had died from acute disease ('Guy's Hospital Reports,' October 1863). It would appear as if some diseases had either directly or indirectly a retarding influence over the process. It has been also remarked that the bodies of plethoric persons who have died suddenly while in good health, have undergone rapid decomposition. (In persons who have died from asphyxia, as by drowning, suffocation, or strangulation, the bodies are, *cæteris paribus*, observed to putrefy with great rapidity; and as a general rule all those parts of the body which at the time of death are irritated, congested, or inflamed, are rapidly attacked by the putrefactive process.)

Conflicting statements have been made regarding the process of putrefaction in the bodies of those who have died from certain poisons. Thus it has been stated that in death from prussic acid, morphia and vegetable poisons, putrefaction generally commences early and progresses with rapidity, while strychnia has been supposed to exercise a retarding power. In poisoning by vegetable narcotico-irritants the blood is observed to be frequently dark-coloured and very liquid, and it may therefore have undergone some chemical change, which may render it more prone to decomposition. But the observations elsewhere made will at once account for the conflicting statements, and show that putrefaction may be accelerated or retarded under the influence of the same poison, according to the mode in which it operates on the muscular system at the time of death. Thus when strychnia destroys life rapidly, without exhausting the muscular irritability by frequent convulsive

fits, putrefaction takes place slowly; but if all muscular irritability is destroyed before death, it speedily supervenes, and runs through its stages rapidly. As a general rule putrefaction is not set up in a body so long as cadaveric rigidity remains in the muscles. When this condition comes on late, and lasts for a long time, it is slow in appearing, whatever may be the nature of the poison: under opposite circumstances putrefaction takes place rapidly, provided the circumstances are favourable. In a death from nicotina in which all muscular irritability appeared to be destroyed, putrefaction commenced early and in a few hours had made great progress. The body was bloated, and the skin tense and much discoloured.

Some poisons, by chemically combining with animal matter, appear to confer on it the power of resisting putrefaction, at least to a very great degree. This is now a well-known property of arsenic; and in the arts, this poison is largely employed as an antiseptic. When a solution of it is injected into the arteries of a dead body, it tends to preserve it for a long time from putrefaction. In examining the bodies of persons poisoned by arsenic, after an interment of six, twelve and twenty-four months, I have found the stomach and bowels remarkably preserved; and the liver, spleen, and heart also preserved, but in a less perfect manner. The preservative effects are occasionally such that I have seen the pathological changes in the mucous membrane, well marked after the body had been nearly two years in the grave. At the same time, it must be admitted that this preservative property is not manifested in all cases; hence we must not fall into the error of affirming that the person has not died from the effects of arsenic, because the viscera are much putrefied. The greater part of the poison may have been expelled before death, or only a small dose may have been given to the deceased. These facts respecting the action of arsenic are now so well known to lawyers and medical men, that they are seldom disputed. Nevertheless in a trial for murder at the Lewes summer assizes, 1849 (*Regina* v. *Geering*), an attempt was made to refer the non-occurrence of putrefaction, in a case of poisoning by arsenic, to another cause. The deceased, Richard Geering, died on September 13, 1848, and his body was exhumed April 27, 1849, after an interment of rather more than seven months. When the coffin was opened, the face and upper parts of the body were much decomposed. The viscera which were sent to me were in a remarkable state of preservation. The substance of the heart was quite firm. Arsenic was found in well-marked quantity in all these parts. In the defence, a village undertaker was called to prove that, in burying the body, he had placed a slab of wood immediately above the coffin in order to keep the earth from it. An attempt was thus made to account for the preservation of the body irrespective of the action of arsenic. But this hypothesis was inadmissible. A slab of wood could scarcely affect the ordinary course of putrefaction in a grave; and if it did, it would influence it in all parts equally. In this instance those parts of the body only were preserved, in which arsenic was found: the abdominal viscera, which are commonly the first to undergo putrefaction in its ordinary course, were here less changed than the other organs of the body ('Med. Gazette,' vol. 45, p. 19.) Chloride of zinc, a powerful irritant poison, is another well-known preservative. It retards putrefaction apparently by combining with the tissues. In the case of *Ann Palmer* (*Regina* v. *Palmer*, 1856), whose body was exhumed after twelve months' burial, all the organs were found preserved; they contained antimony, which had penetrated even to the ovaries and the substance of the uterus.

Accelerators of Putrefaction.—It has been alleged that there are certain chemical substances which have the property of accelerating the process of

putrefaction: and among these *lime* has been particularly mentioned. The strong mineral acids and alkalies, in a concentrated state, act powerfully as solvents of the soft structures of the body: but they destroy it by immediately corroding it, and not by producing any changes in it analogous to putrefaction. Persons who have been guilty of murder have endeavoured, but ineffectually, to destroy the dead human body rapidly;—sometimes by attempting to burn it, and at other times by the use of nitric acid or lime. The attempt has generally failed. Dr. Webster endeavoured to dispose of the dead body of Dr. Parkman by employing various chemical reagents, but without effect. In the case of the Mannings (*Reg.* v. *Manning and wife*, C. C. C. October 1849), it came out in evidence, that the body of the deceased O'Connor was buried in a hole beneath the stone floor of a kitchen. The two prisoners, in order to destroy the body, poured over it a pint and a half of vitriol, and then covered it with fresh burnt lime, which was slaked upon it under the idea that this would rapidly destroy it; but the body was disinterred, and all the facts necessary to show that the deceased had been murdered, were clearly brought out. At the trial it was stated by one of the medical witnesses that lime would certainly cause a dead body to decompose more rapidly, that the features would be thereby much disfigured, and the brain reduced to a fluid state. This theory was set up in order to account for the apparently rapid putrefaction of the body, compared with the time that deceased had been missing: but this was sufficiently accounted for without resorting to this hypothesis, by the season of the year (August) and the superficial interment. The medical opinion here given regarding the effect of lime, was in accordance with a popular view which appears to be incorrect. Some years previously to the trial of the Mannings, the dead body of a child, placed in a box and covered with lime, was brought to me for examination in reference to a charge of infanticide. Considering the period of death and the season of the year, the body was in a better state of preservation than might have been expected. The abdomen and lower extremities, which had been completely covered with powdered lime, were very well preserved. There was nothing to show that the lime had exercised any accelerating influence. On the contrary it had probably retarded putrefation by keeping off air. A stiff cream of lime has no corrosive or caustic action on the skin or muscles: its chief use in the tanning of skins, is not to corrode them, but to combine with and remove the fatty portions. Comparative experiments were performed with powdered lime partially slaked by exposure, on portions of raw flesh. The flesh acquired a greenish colour on the outside, but was speedily dried by the action of the lime, and after five weeks it was found that putrefaction had become arrested, and the flesh was harder and firmer than a similar portion which had been exposed to air during the same period ('Med. Gazette,' 1850, vol. 45, p. 20). Dr. John Davy from the results of his experiments has arrived at a similar conclusion. With the exception of cuticle, hair, and nail, which were softened by the action of wet lime, he found that this alkaline earth did not exercise any destructive or corrosive power on animal substances generally, or had any effect in promoting their decomposition. On the contrary, in the dry state, it exerted a preservative and decidedly antiseptic power, arresting putrefaction even after it had commenced ('Med. Gaz.' Jan. 1850).

2. Putrefaction in the Earth.—Exhumations are occasionally required for the purposes of justice, and it is under these circumstances that opportunities may occur for observing the progress of putrefaction in the dead. Unfortunately the results of these observations have hitherto led to no satisfactory

conclusions; for sometimes one body has been found more decomposed after six or eight months' burial, than another which has lain interred for a period of eighteen months or two years.

From facts hitherto collected, especially from the researches made by Orfila, it would appear that the changes which take place are similar to those described in speaking of putrefaction in air. There is in the first instance a discolouration of the skin of the abdomen, owing to decomposition taking place more readily in the contents of the viscera. The skin of the whole body becomes green, and the epidermis is loose and easily detached by pressure or friction. The muscles also acquire a dark green colour. are more or less pulpy, and in the course of time lose their fibrous character. The lungs are distended with gases, and completely fill the cavity of the chest. The heart and liver are softened, and acquire a dark slate colour. The same change is observed in the spleen and kidneys—the fat around the latter organs being commonly white and firm. The whole of these organs will be found much reduced in size; thus the liver may weigh no more than a pound or twenty ounces. The surfaces of the soft organs, especially of the liver, frequently present small circular patches of a hard white crystalline substance, which is insoluble in water. It consists chiefly of crystals of phosphate of lime with organic matter, and in some instances associated with the phosphate of ammonia and magnesia. I have found these crystalline deposits in bodies which have been exhumed at periods varying from one to three years after interment. When the process is farther advanced, the soft organs are filled with bladders of air, and float on water. The stomach, intestines, and urinary bladder have their mucous surfaces stained with patches of a brown, green, or deep slate colour. Sometimes these stains are of a coaly blackness. The coats of the stomach, if entire, may be closely adherent. They are very thin, difficult to separate, and are frequently ruptured in the attempt to examine them. All the contents may have disappeared with the exception of a thin layer of a black-looking substance, which is probably decomposed blood. The lining membrane is sometimes covered with deposits of small hard crystals of phosphate of lime, or phosphate of ammonia and magnesia. These must not be mistaken for crystals of white arsenic. The stomach and intestines may be stained of a deep orange or yellow colour with bile. This may be identified by its forming a green-coloured solution when boiled in hydrochloric acid. The marks of irritant poisoning, and those pathological changes in the viscera, which are so characteristic of death from poison, are now lost in the discolourations produced by putrefaction. As the process advances, the body becomes covered with fatty incrustations of a reddish-brown colour, and the interstices are filled with the common blue, white, or green mouldiness, intermixed with a reddish-coloured fungus. The skin and soft parts become thin, fall off in places, and expose the bones. The coverings of the chest and abdomen are so collapsed as to be in contact with the anterior portion of the spine. The muscles are considerably reduced in bulk; and they may be found in part converted into adipocere. The viscera are also much shrunk, collapsed, and often, if we except the stomach and duodenum, so intermixed, that it is not possible to identify or separate them. The liver may in this way be found incorporated with the lungs, owing to the destruction of the diaphragm; and the brain completely collapsed. In one exhumation, after four years' burial, the whole of the soft parts of the chest and abdomen formed a soft whitish-yellow mass disposed in condensed layers. It was impossible to distinguish the stomach from the liver, intestines, or lungs. The periods of time over which I have had an opportunity of examining exhumed bodies, have varied from one month to eight years. In the case of *Peter Mawer*, whose remains were exhumed at

Boston in 1862, after eight years' burial in a damp grave, the body was in fragments, the soft parts loosely adhering to the bones, immersed in a large quantity of water in the coffin. The muscles, soft organs, and skin were converted into a white sodden mass, in which no organ or part could be identified. The mass had a fibrous structure: it contained oily matter, and had a very offensive odour like decayed cheese. The bones were of a dark colour: they could be drawn perfectly clean out of the soft parts. The water of the coffin contained phosphate and sulphate of ammonia, with animal matter.

At this period the features are entirely destroyed, and the form of the skull and skeleton generally, is apparent. In a still more advanced stage, scarcely any traces of the soft organs are to be met with. The muscles, if not already changed as above described, pass to the condition of brown foliaceous masses. This is chiefly observed in those bodies which have been buried in a dry gravelly soil. The bones are disarticulated, the long bones giving the perfect outline of the skeleton, while the short and flat bones, including the bodies of the vertebræ with the base of the skull, are converted into a brownish-white pulverulent mass, mixed with the friable remains of the wooden coffin in which the body was buried.

It has been found utterly impossible to assign any definite period of time to these changes, or, from an observation of them, to give any certain opinion respecting the length of time which a body has been interred. The reason is obvious: bodies undergo these changes with very different degrees of rapidity, even when they have been interred under similar circumstances. In one body, buried for a period of nine months, and in another for thirteen months, there were no traces of the coverings of the abdomen to be discovered; in a third, these coverings were found almost entire after a burial of twenty-three months; yet these three bodies had been wrapped in cloth of the same texture, and buried by the side of each other in coffins of the same kind of wood (Orfila). In the recent removal of the remains of about two thousand bodies from St. Andrew's churchyard for the Holborn Viaduct, some bodies were found well preserved. They were mummified, dry and like tanned leather. In one case, that of a man, the clothes were quite perfect; in another, that of a lady whose body had been buried considerably over a century, the lace on the grave-clothes was perfect and only slightly changed in colour.

It is commonly said that the soft parts are entirely destroyed in a period of from seven to ten years; but this must depend on the circumstances under which the body is buried, *i. e.*, the kind of coffin, the nature of the soil, and the depth of the grave. Devergie states, that in one instance he met with no trace of a shroud in a body which had been buried three years and a half, while in another a portion was discovered after seven years' interment. I had an opportunity of examining a grave in which a body had been buried twenty-five years. Soft fragments of the coffin of a dark brown colour were found, but of the body only the skull (excepting the base) and some portions of the long bones remained. In an adjoining grave, nearly the entire skeleton was discovered lying at full length, surrounded by the decomposed coffin. This was after thirty-four years' burial, and the bones were nearly all perfect. I also found here traces of the shroud on the inside of what had been part of the coffin-plate, and the texture of linen was made evident by submitting it to the microscope. Unless the body has been buried in metal, or converted into adipocere, it is not probable that any of the soft parts will be found, in a soil favourable for decomposition, after ten or twelve years. They may exist as a sort of unctuous fat mixed with the wood and earthy matter, but they are not likely to be in a condition to admit of identification. Perhaps the

usual period for the destruction of the soft parts in thin wooden coffins may be taken at about ten years.

In most instances of judicial exhumation the period of interment is well known, and no opinion is required of a medical witness on this matter. The only case on which he may be called upon to give an opinion is, where a skeleton or some bones have been discovered lying loosely in the soil. This part of the subject will be considered hereafter. Great embarrassment might exist in defining the period of interment in an unknown case, when a body has been buried in a coffin; but this does not, for obvious reasons, occur in practice. The bodies of those who have died by a violent death are commonly buried superficially in loose ground without a coffin; hence the data obtained by examining the progress of decomposition of bodies placed in coffins, even if they were more precise, could rarely be available for practical purposes. As the teeth, the bones, and the hair are among the most indestructible parts of the body, it will be necessary in an exhumation to look for any portions of these that may remain. They often throw light upon the age and sex of the individual, and serve to determine questions of identity.

The circumstances which modify the progress of putrefaction in the earth may be in some measure anticipated from what has been already said of this process in air. Among them may be enumerated the period during which the body may have been exposed to the atmosphere before interment, the nature of the soil in which it is buried, and the depth of the grave, with other circumstances, the precise influence of which it is difficult to estimate. There are a few special conditions which may affect the decomposition of bodies buried in the earth:—without a knowledge of them a witness may be led to express an erroneous opinion. The most important are—

Date of interment.—It is well ascertained that a body putrefies much more rapidly in air than in any other medium; hence, if it be kept long exposed before it is interred, putrefaction will take place much more readily, and advance to a much greater extent, than if it had been buried soon after death. On this subject it may be remarked, that, if a body be kept exposed during the summer for five or six days, and then interred, it may be found on exhumation, after the lapse of a month, that putrefaction is as far advanced as it would have been after the lapse of several months, supposing that the subject had been interred within a few hours after death. Owing to this circumstance there is a difference in the rapidity of decomposition according to whether the bodies on which the observations have been made were interred after exposure to a hot and moist, or cold and dry atmosphere. It has been already stated, that the period at which cadaveric rigidity of the muscular system ceases is that at which putrefaction may be considered to commence. Many circumstances have been pointed out, which retard or accelerate the access of this condition of the body. When cadaveric rigidity has been retarded by any of the circumstances mentioned, the putrefactive process will necessarily be a longer time in making its appearance. When the rigidity is a speedy consequence of dissolution, we may expect that putrefaction will take place rapidly.

Nature of the soil in which the interment takes place.—If the ground is elevated or on an acclivity, it will commonly be dry, and decomposition will be retarded: if a body is buried in a low situation, or in a valley, the soil being generally damp, decomposition will be hastened. A dry and absorbent soil invariably retards putrefaction; and thus, bodies buried in the sands of Egypt, become often perfectly desiccated, and resist the process for a long series of years. The chemical nature of the soil, also, has an influence, which may be briefly stated. In sand, gravel, or chalk, putrefaction goes on more slowly than in other soils, and adipocere is rarely met with, unless there is

free access of water, when that portion of the body exposed to the contact of water may become adipocerous. In marl or clay, if air has access, the process takes place more quickly, especially in loose mould or in any porous soil much impregnated with animal or vegetable matter. It is in these last-mentioned soils, provided they are not too dry, that the formation of adipocere is observed; and however great the rapidity with which putrefaction may have advanced previously, it is either suspended or modified on the occurrence of this change. By a reference to the nature of the soil, therefore, we may often explain why a body, after having been interred for a considerable number of years, may be exhumed apparently unaltered by decomposition. The whole of the soft parts may have become converted into this white substance; but although the physical outline may be preserved, the texture of the organs will be completely changed.

Depth of the grave.—Observation shows that the deeper the grave, the longer putrefaction is retarded. This may depend upon several circumstances: as the want of a free access of air in deep graves, and the uniformly low temperature which is known to prevail, at all seasons of the year, at a certain depth below the surface of the soil. Bodies buried in shallow graves are subject to all the fluctuations of temperature which take place during the day and night, and throughout the seasons of the year; they are therefore most favourably placed for the rapid progress of putrefaction. According to the most accurate observations, the diurnal changes of temperature extend to about three feet in depth below the surface, while the monthly changes are perceptible to the depth of six feet. Bodies buried below this depth putrefy slowly, *cæteris paribus*, owing to the uniform and comparatively low temperature which is there maintained. As in these cases there is no free access of oxygen, ammonia and sulphuretted hydrogen are abundant products of decomposition. The exposed parts of the skin are soft, completely brown like the skin of a mulatto, and the limbs, as well as the face, are thickly covered with a soft white fungus. Such has been the condition of bodies of which I have witnessed the exhumation, after an interment of from one to two years.

The state in which the body is buried.—Putrefaction is more rapid in bodies buried naked, than in those which have been buried wrapped in clothes. This point may be a subject requiring especial attention in investigations relative to infanticide, since the bodies of children are usually thrown naked into a pit, and loosely covered with earth. The process is less rapid when the body is interred in a close coffin: and when the latter is formed of an imperishable material, such as lead closely sealed, putrefaction is speedily arrested; and the deceased may be recognized after the lapse of many years. The reason why bodies are comparatively preserved under these circumstances, is obviously owing to the access of air being cut off. Any confined mass of air, so soon as the whole of the oxygen contained within it, is removed by combination, acts antiseptically, forming an atmosphere of nitrogen which retards putrefaction, and thus the body may be preserved for a long period.

Formation of Adipocere. Saponification.—In the course of these observations, I have had frequent occasion to speak of the dead body becoming sometimes converted into adipocere: it will be therefore proper to explain what is meant by this process of conversion.

The substance called *adipocere* was first observed and described by Fourcroy during the removal of vast numbers of bodies from the Cimetière des Innocens in Paris. He gave to it this name, owing to its properties being intermediate between those of wax and fat. He considered it to be constituted

of fatty matter and ammonia. From an analysis by Chevreul, the substance described by Fourcroy was proved to be a real ammoniacal soap with some extraneous colouring matter, which gave it a yellowish or brown colour. It contained, besides, a bitter substance not defined, and an odoriferous principle, to which it owed its smell. Chevreul also detected in some specimens, lime, potash, and salts. The composition of adipocere does not appear to be uniform: it is liable to vary according to the nature of the medium to which the body has been exposed. Thus, in hard or river water, the white substance so called, discovered in the dead body, is formed of a base of lime; so, in bodies laid in graves or vaults which are traversed by springs of water containing sulphate or carbonate of lime, an adipocere of stearate and oleate of lime is found as a hard white solid. It is not improbable, as Orfila has suggested, that in the first instance an ammoniacal soap is produced, and that this is subsequently converted into a calcareous soap by contact with calcareous water. Indeed, Orfila states that he experimentally established this point, by placing ammoniacal soap in maceration in a solution of sulphate of lime. In three weeks, he found that the calcareous had been substituted for the ammoniacal base.

Any part of the human body may undergo this change, but all parts are not equally susceptible of it. In order that the adipocere described by Fourcroy should be found, it is indispensable that the animal fat should be in contact with substances containing nitrogen. Experiment has clearly established that neither pure fat, nor pure fibrin, when kept apart, will become saponified. Orfila found by comparative experiments, that the skin deprived of all fat did not undergo this change; but when the fat was allowed to adhere to it, it became saponified. Upon the knowledge of these facts, the following theory of the production of adipocere was founded. The fat containing no nitrogen, could not furnish ammonia; consequently it could not spontaneously change into this substance. The fibrin of the muscular system was therefore supposed to produce ammonia, by giving off hydrogen and nitrogen; and this alkali combined with the fatty acids of the body to form a soap (see 'Ure's Dictionary,' art. Adipocere). Devergie has shown, that the fat of the female breasts, that of the hollow of the cheeks, and other large fatty accumulations, are the first to take on this change, while the fatty layers immediately in contact with the muscles, present no appearance of saponification, until a considerably later period. We have observed this change in a body after interment for a year, in the fat of the kidneys and omentum, as well as in the fatty appendages of the large intestines. As the fat of the body is contained in a cellular membrane (a nitrogenous compound), and is traversed by the blood and other nitrogenous fluids, the nitrogen is as readily furnished by these, as by the fibrin of the muscles. So, again, the skin and fat, separated from the muscles, will become converted into adipocere. The fibrin of muscles, therefore, although unquestionably it may be one source of the ammonia, is not the sole source. Oil or fat exists throughout the soft organs and tissues of the whole body; hence every part may undergo this transformation. When the change is complete, the body maintains its condition for many years. Thus, in one instance, after seventeen years' burial in a grave, an exhumed body was found to be converted into this substance, and many of the organs could still be identified ('Phil. Med. Exam.' April 1847, p. 247).

This process takes place most readily—1. In the bodies of young persons, the fat being chiefly external and very abundant. 2. In those adults whose bodies abound in fat. 3. In bodies exposed to the soil of water-closets. 4. In those immersed in water, but somewhat less rapidly in stagnant than in running water. 5. Readily in humid and fatty soils, especially in grave-yards, where numerous bodies have been piled in contact with each other. In

this latter case, those which are situated at the lowest level have been observed to become the soonest saponified. The period required for saponification to take place varies according to circumstances. Devergie states that the body of a new-born child in the soil of water-closets may become entirely saponified in from six weeks to two months; while in a drowned subject in water, saponification may be partially met with in three or four months; and in one buried in a damp grave, from two to three years may sometimes elapse before saponification is complete. There is no doubt, however, that the process may take place partially in the dead body, within much shorter periods than these. A body floating in water has been found converted into this adipocerous state in a little more than five weeks; and with regard to the period in an ordinary grave, I may refer to the case of a female, exhumed at Bristol, in 1835, after fourteen months' interment. The lower part of the body was here found adipocerous. It appears that the grave was very damp, and the line of adipocerous transformation in the deceased was bounded by the level to which the water had reached. These facts are of more importance than may at first sight appear, since a legal question of survivorship, in at least two cases, has turned upon the shortest period required for the production of true adipocere in the dead body.

Properties of Adipocere.—Fourcroy and other French chemists describe adipocere as an unctuous, soapy substance, varying in colour from a pale white to various shades of yellow or brown. In the first instance it is soft, but becomes harder and lighter in colour when dried. It melts at 200°, and when strongly heated in air gives off an ammoniacal odour, inflames, and burns. It is easily suspended in cold water, and forms an opaque mixture on boiling. Acids decompose the solution by combining with the bases, forming salts. When heated with lime, ammonia is evolved. It is only partly dissolved by boiling alcohol. Adipocere with a calcareous base is harder and whiter than that which contains ammonia. There is no trace of organic structure in either.

Having had an opportunity of examining this substance as it is found in bodies after long interment in damp graves, I here subjoin a description of its properties. A man named *Peter Mawer* died and was buried at Boston in October 1854, and his body was exhumed for judicial purposes in June 1862. I have already described the condition in which it was found after an interment of eight years (see page 104). The white substance into which all the organs had been completely transformed was unctuous to the touch, and had a peculiar and highly-offensive odour. When completely dried it was soft, white, somewhat brittle, with a fibrous structure, and crumbled under the knife. Examined by the microscope, it presented none of the usual characters of muscular fibre. It appeared to be a confused network of fibres cemented by a white, fatty-looking substance. It had a disagreeable rancid odour, which was increased when the substance was heated. It was in great part dissolved by alcohol, and the solution became opaque on adding to it water. It readily floated on water, forming an opaque solution when boiled: the greater part was dissolved, but the liquid did not become clear on filtration. The solution had a slightly acid reaction on litmus paper. When heated with potash, it became clear, and evolved ammonia. The substance was almost entirely soluble in potash, and the solution gave a white precipitate with acids. The potash solution gave no trace of the presence of sulphur. It formed a red-coloured liquid when boiled in strong hydrochloric acid. It was carbonized by sulphuric acid. The aqueous solution contained no sulphuric or phosphoric acid or lime: it contained an abundance of alkaline chloride with animal matter which reduced nitrate of silver. It was only partially fused at 212°. When heated

in a close tube, it gave out an offensive rancid odour; it evolved ammonia and traces of sulphur; it readily melted, and by continuing the heat, a dense oily vapour having an acid reaction was distilled over—a carbonaceous residue being left in the tube. When heated on platinum, it melted, took fire, and burnt with the bright yellow flame of hydrocarbon. It left a mineral residue of a brownish colour owing to the presence of oxide of iron: this residue amounted to five per cent. of its weight. The residue was in great part soluble in water, the solution having a strong alkaline reaction and effervescing with acids. It contained the carbonates of potash and soda, with phosphate of lime and chloride of sodium, as well as traces of alkaline sulphate and oxide of iron. Adipocere, therefore, does not appear to be a definite compound. It is a variable mixture of the fatty portions of the body with altered organic tissues. It contains in a concentrated form, besides ammonia as a result of decomposition, the bases as well as the salts which are found in the animal solids and fluids. These appear to be intimately combined with the fatty portions of the tissues.

CHAPTER 7.

INFERENCE OF THE PERIOD OF DEATH IN A BODY AFTER PUTREFACTION—INSTANCES OF RAPID DECOMPOSITION OF THE BODY—PROBABLE CAUSES—DETERMINATION OF THE TIME OF DEATH—PUTREFACTION SUSPENDED: CASE OF DESHA—PUTREFACTION ACCELERATED—CASES OF MRS. BYRNE AND JOSEPH MAHAIG—MARKS ON THE SKIN—PROTRUSION OF THE EYE AND TONGUE AS A RESULT OF PUTREFACTION OR STRANGULATION—PUTREFACTION IN WATER—PERIOD OF IMMERSION IN WATER.

Inference of the period of death in reference to a body after Putrefaction.—Orfila, after having devoted many years to the investigation of this subject, and after the comparative examination of some hundreds of exhumed bodies, of all ages, and of both sexes, came to the conclusion, that it was beyond the reach of science to determine with accuracy the period of death, from the progress of putrefaction. Bodies which had been buried for an equal length of time in the same soil under apparently similar conditions, frequently presented such differences as to baffle all attempts at generalization. This question becomes even more difficult, when the body is submitted to examination, and none of the conditions under which the person has died, or to which the body has been exposed after death, are known. It will be perceived from what has been already stated, that the circumstances which affect the rate and progress of putrefaction, are numerous and of a variable character. If we can obtain no history of the case, a medical opinion can be little more than a conjecture; if, however, we are informed of the atmospheric and other conditions to which a dead body has been exposed, it may then be in our power to arrive at a probable, if not a definite conclusion. In the description of the modifying conditions above given, the practitioner will find some points which may render him assistance, or, at any rate, enable him to avoid some of the serious errors which have been made by medical witnesses in reference to this subject. It has been elsewhere stated, that putrefaction does not commonly commence, until about the third day after death, at any rate there is usually no external sign of the process until that date; but there are many instances known of its commencing almost immediately after death, and proceeding with great rapidity, while, in other cases, more than twenty days have passed without any indication of its presence.

The experience of my colleague, Dr. Wilks, who for many years conducted the post-mortem examinations at Guy's Hospital, and who had thus had an opportunity of inspecting more than four thousand dead bodies, may be here briefly referred to. At Guy's Hospital, most cases are inspected within twenty-four hours after death, when, as a rule, the body is rigid and no decomposition has taken place. If after two or three days much change should be present, it is generally to be attributed to some peculiarity in the cause of death. The decomposition is not shown, as at a still later period, by a mere change of colour, as a greenish hue of the abdomen, but by a redness of the whole body, and by dark stains in the course of the superficial veins. Even when these external changes are scarcely observable, there may be found considerable alterations within the body, shown more especially in a discolouration of the heart and arteries by the blood. These changes appear to be connected with a diseased state of the blood, and are met with in those who have died of fever, pyæmia, and similar maladies. In cases of strangulated hernia, in which death speedily follows an operation, the post-mortem changes are sometimes observed to be very rapid. It is a common observation, that moisture in the atmosphere appears to favour decomposition much more than heat: thus putridity is much more rapid on a moist winter's day than on a hot dry day in summer. These facts may be illustrated by cases from the records.

In September 1855, the body of a man was examined thirty-eight hours after death from an accident; it had begun to undergo decomposition in the ordinary manner. The body of another man, who had died of phthisis, was examined forty-four hours after death, and in this there was no trace of decomposition. On the following day an inspection was made of the body of a man who had died in a few hours after fracture of the ribs. Only forty-eight hours had elapsed since death, but considerable decomposition had already taken place.

Sometimes decomposition is so rapid that in a few hours the features of a person are unrecognizable. A man, æt. 26, died on November 28th, 1855, of typhoid fever, and perforation of the ileum. The weather was cold and moist. When the examination was about to be made sixteen hours after death, the body was wholly unlike that of the man when alive. There was no rigidity; the whole body was bloated; the cellular tissue was greatly distended, so that when the skin was pierced the gas which escaped was easily ignited into a flame. The colour of the surface was of a reddish hue. The internal organs were also much decomposed; of a dark colour, soft, and emitting a very fetid odour. The liver was full of air. The patient was a temperate man, and had resided in the country.

Mr. W. Clegg, of Boston, gave me a note of the following case:—In November 1864, a plethoric man met with an accident, and died at 10 o'clock P.M. Mr. Clegg held an inquest on the body the next morning at 11 A.M. Although only thirteen hours had elapsed since death, the body was highly putrefied, presenting a bloated appearance, and the face was so swollen and discoloured that the features could not be recognized. The gases which escaped were so offensive that the jury could not approach the body. No inspection was made.

A man, æt. 35, shot himself with a pistol, producing fracture of the skull and injury to the brain, from which he died in six days. On December 13th, 1854, the atmosphere being cold but moist, the body was brought into the room for examination, thirteen hours after death. The rigidity was imperfect, but still present to a slight degree; the body was warm; when opened, it showed that a remarkable change had taken place internally, so that it was even suggested whether decomposition had not commenced before death. The brain was soft and decomposed; the lungs showed recent inflammation and

the air-tubes were deeply stained by imbibition; the interior of the heart and arteries was of a dark purple colour, and the clots in the heart were mixed with air; the peritoneum was discoloured; the liver presented a remarkable appearance, it was full of air, and thus resembled a mass of fermenting dough; on the surface were bubbles of air ready to burst: this organ contained two small pyæmic abscesses. The spleen was of a greenish colour; the kidneys closely resembled the liver, being like it distended from decomposition, and containing air-bubbles throughout their substance. (See 'Guy's Hospital Reports,' October 1863, p. 181.)

In addition to these cases, Dr. Wilks communicated to me another, in which a man, æt. 50, died in Guy's Hospital, from an accident in December 1860. He lost much venous blood, and, without showing any sign of rallying from the accident, he died on the fourth day after his admission. For a few hours before death, he suffered from great difficulty of breathing, and his pulse was not perceptible. The man died at 6 P.M., and in an hour or two his body was carried to the dead-house. The weather was frosty, and it was a hard frost during the night that the body lay in the dead-house. On the following day (only twenty hours after death), putrefaction had advanced to such a degree, that the deceased could scarcely be recognized. The skin was throughout distended by the gases of putrefaction. All the viscera were decomposed, the liver contained putrescent gases, and even the coats of the gall-bladder were distended with them. This was a case of rapid death, probably from blood-poisoning.

The following is a remarkable instance of the rapidity with which putrefaction may take place in a dead body. A man, æt. 39, was admitted into Guy's Hospital in October 1849. He was fat, of pale complexion, and of intemperate habits. The muscles were flabby. He died suddenly after a few days, without suffering from any symptoms indicative of danger. His death took place at 10.30 P.M., the body remained in the ward until 8 A.M. the following morning, the air having a temperature of from 60° to 65°. The conditions as to cooling and rigidity were not observed during the night; but when removed at the hour mentioned, decomposition had already commenced. The skin on the left side was raised in large bladders, containing a bloody liquid. At 2.30 P.M. *i.e. sixteen* hours after death, the entire skin was more or less of a blue or purple colour; the eyes protruded from the sockets, and the nostrils were filled with a bloody froth, from which minute bubbles of gas continually issued. The abdomen, as well as the scrotum, was greatly distended with gas. The groins were much putrefied and were covered with minute blood-vesicles. I saw the body *seventeen hours* after death. The skin of the neck and face had then a bloated and tense appearance from the collection of gas beneath. Blue, green, and livid red discolourations were seen more or less over the whole surface, with bladders or vesicles as in the advanced putrefaction of bodies after some days' exposure in hot weather. The gases which issued in jets from every part of the skin in which a puncture was made, were highly offensive. When a flame was applied to the puncture, the gas burnt suddenly, with almost explosive violence. The gas did not discolour slips of paper moistened with acetate of lead or nitrate of silver: hence neither sulphuretted nor phosphuretted hydrogen was present. It burnt like the bright carburetted hydrogen; and I believe that it was this gas, mixed with other gases and vapours derived from putrefaction. When the tense skin of the scrotum was punctured, a jet of carburetted hydrogen escaped, which burnt steadily, with a pale yellowish flame, for above a minute. The state of the body precluded a post-mortem examination, which was considered unnecessary ('Med. Gaz.' 1850, vol. 45, p. 17). This case resembles in its features one which occurred to Dr. Wilks.

The condition of this body in reference to the process of putrefaction was such as M. Devergie assigns to dead bodies at a period of six to twelve days after death, on the assumption that they have been freely exposed to the air, at a mean temperature ('Med. Leg.' vol. 2, p. 406). Had the body of this person been found in a house under these circumstances, and had the history of the case been entirely unknown, a medical man, asked to assign a period of death, from common experience in such matters, might have declared it to be impossible that the deceased could have been living within twenty-four hours previously to the discovery. Suspicion might thus be removed from persons really guilty of murder, because it might be proved that they had not been in or near the house until within a day of the discovery of the body. On the other hand, an innocent person who had been seen in company with the deceased five or six days previously, or who had voluntarily remained in the same room with the body, might be unjustly charged with having been accessory to his death. This, with other instances of a similar kind, shows that unusual caution is required in expressing a medical opinion on the time at which death took place, in bodies which are found much decomposed.

The causes of this rapid access and progress of putrefaction in the body of a man dying in the prime of life, cannot be assigned to the season of the year or to the operation of any unusual external influences. It may have been due to the condition of the body, especially of the blood, at the time of death. This man was of intemperate habits, with a flabby muscular system, and low vital energy. These were precisely the conditions favourable to the speedy loss of muscular irritability after death, with the appearance and disappearance of cadaveric rigidity after an unusually short duration. The fourth or putrefactive stage was therefore reached in a few hours. The ward temperature, 65°, was favourable to the process, and the blood and other fluids were probably prone to decomposition. Although the body was removed into a cooler atmosphere on the morning following death, yet the process having once commenced, progressed with great rapidity.

The late Sir Henry Marsh has described a case of a somewhat similar kind. A man who had been ill about fourteen days, was admitted into the Hotel Dieu, at Paris, under M. Bally. He died on the night after his admission; and on examination only *eight hours* afterwards, his body presented the following appearances:—The whole of the skin was distended with air; it was of a violet colour, and studded with a vesicular eruption in detached spots, the vesicles being filled, some with a reddish-coloured serum, and others with gas. The abdomen was also much distended by gas, this having accumulated not in the intestines, but in the cavity of the peritoneum. Upon cutting into any emphysematous part, an inflammable gas escaped which was readily ignited by the flame of a candle. From a perforation in the abdomen it issued and burnt with a blueish flame (sulphuretted hydrogen or carbonic oxide). ('Ed. Med. Journ.' vol. 58, p. 501.) It was thought this state of the body indicated putrefaction before death; but it was merely an instance of its rapid supervention after death.

The experiments and observations of M. Brown-Séquard, already referred to, tend to explain many of the supposed anomalies which present themselves in the commencement, progress, and duration of the process of putrefaction. The various physical and physiological conditions which affect muscular irritability, and, with this, cadaveric rigidity in a dead body, equally influence the process. The time for its commencement in a dead body is defined by the cessation of cadaveric rigidity, and this condition again has its commencement defined by the loss of muscular irritability. Some experiments on dogs, elsewhere related (page 60), show that when rigidity appears and disappears shortly after death, putrefaction is speedily manifested in a

body, and it progresses with great rapidity. It has been long known that the flesh of hunted or over-driven animals rapidly undergoes putrefaction. Brown-Séquard, in September 1851, saw two sheep that had been over-driven to reach a fair. They were killed by the section of the carotid arteries. In less than five minutes after death rigidity was evident in both of them; and putrefaction was manifest before the end of the day, *i.e.* in less than eight hours after death ('Proc. R. S.' 1861, No. 44, p. 210). Whatever exhausts muscular power at the time of death, whether it be violent exercise, disease, or poison, tends *cæteris paribus* to accelerate putrefaction, and to cause it to spread rapidly. Thus among persons killed by lightning or by strychnia, the body of one may putrefy rapidly, while that of another goes through the ordinary course. It is not due so much to the effect of the agent as it is to the mode in which it has destroyed life.

There is great difficulty in the practical application of these principles to the determination of the probable period of death, in reference to the body of a person found dead. Medical opinions are frequently required in cases of alleged child-murder on the probable date of death of a child, whose body has been found in a putrefied state. With a due regard to the conditions under which the body has been placed, a medical witness may occasionally be able to say whether its state was such as to be consistent or inconsistent with the delivery of an accused woman at a particular period of time.

Greater difficulties occur on charges of murder in reference to the bodies of adults found dead under suspicious circumstances. The connection of an accused person with the act may occasionally turn upon a medical opinion respecting the state of the dead body. Dr. Beck furnishes a case illustrative of this statement. A man named *Desha* was charged with the murder of Francis Baker. The deceased was last seen with the prisoner on the 2nd November 1824. The body of the deceased was found on the 8th November, *i.e.* six days afterwards, in a sheltered hollow, with the throat cut, with several wounds on the head, and a wound on the chest. There was no doubt from the nature of the wounds that the deceased had been murdered, and that he must have died soon after their infliction. The defence of the prisoner rested to a great extent on the condition of the body when found, the principal question being, whether the state of the body was consistent with the suggestion of violent death caused *six days* previously. When discovered, it had undergone so little change that it was considered deceased must have been alive some days after the prisoner had been last seen in his company. The body when first found, is described as having been a little stiff; but after carrying it some distance it became pliant. There was no appearance of putrefaction about it, either by the smell or by any change of colour in the skin. In two days after its discovery, during which period it had been placed in a room in which there was a fire, putrefaction set in, and the abdomen and face became much swollen and decomposed. At this time *i.e.* the eighth day after the deceased had been seen alive, much blood issued from the wounds; according to one medical witness the wounds at this date appeared fresh, according to another they did not. There was some conflicting evidence, lay and professional, on the question whether putrefaction could be so completely suspended during eight days as it had been in this instance. The counsel for the prisoner dwelt upon the absence of the process as a proof that death must have been recent, and therefore that the prisoner could have had no share in it. The judge also inclined to this view. In addressing the jury he said, 'It is difficult to suppose that a body, at this or any season of the year, could have remained that long without exhibiting some symptoms of putrescence: connect also that in two or three days after it was found, it did show such symptoms as in that time might

naturally be expected.' Another singular point raised in the prisoner's favour, was that the beard had grown after the discovery of the body, and it was quite short when it was first seen, and had the appearance of having been recently shaven; but in the interval of Tuesday and Thursday, after its discovery, it had become a little longer. Counsel contended that the beard will grow after death; and as, when the body was found, the chin was cleanly shaven, this pointed to recent and not to remote death, as the beard would have already become elongated when the body was found, had the deceased been dead six days! The medical witnesses, in reference to this theory, stated that the appearance of growth after death was to be ascribed to a shrinking of the skin. The jury returned a verdict of guilty. The prisoner subsequently destroyed himself, and, while dying from his wounds, protested his innocence of this crime. ('Beck's Med. Jur.' vol. 2, p. 45.) This case does not appear to present much difficulty. The fact that the body of deceased remained six days in a sheltered spot during the month of November, without undergoing any of the usual changes from putrefaction, is consistent with death six days previously. When found, the body had reached the third stage described by Devergie: it was cold and pliant, or readily became so; it had passed through the stage of cadaveric rigidity. According to the observations of Devergie, a dead body *cæteris paribus* would assume this condition in from three to eight days after death. The fact that putrefaction came on in two or three days after its discovery, although perplexing to the judge, is fully explained by the cessation of cadaveric rigidity and the warm temperature to which the body was then exposed. The state of the beard did not justify the inference that death had been more recent. Neither the age nor the condition of the deceased's body is stated by Dr. Beck, but it is clear that he died suddenly from loss of blood, as well as other injuries. It may be inferred, therefore, that his muscular system was endowed with the ordinary amount of irritability. In cases of healthy persons suddenly killed by decapitation, Brown-Séquard observed that cadaveric rigidity did not appear until ten or twelve hours after death, and that it lasted more than a week when the weather was not extremely warm. The retardation of putrefaction in the above case may have been due to a similar cause.

The medical difficulty in the case of Desha arose chiefly from the suspension of the putrefactive process beyond the average period. Other cases have occurred, in which the rapid access of putrefaction following sudden death has implicated persons in charges of murder, and they have narrowly escaped conviction, apparently because the changes produced by putrefaction had been mistaken for the effects of violence. In August 1842, Mrs. *Ellen Byrne* was tried at the Commission Court, Dublin, for the murder of her husband, Augustine Byrne, by strangulation, suffocation, or other violence ('The Trial of Mrs. Ellen Byrne, for the Murder of Mr. Augustine Byrne, specially reported by T. R. Dunckley,' Dublin, 1842). The prisoner and deceased, who were in a respectable condition of life, were in the habit of drinking to excess. On this occasion they had retired to their bedroom, and about four days after the deceased had been last seen alive, and eight days after they had been in the room, the body of the husband was found dead on the bed, while the wife was in the room. She professed not to know that her husband was dead, and sent for a medical man. From his evidence, it appeared that when he first saw the body on Saturday evening (July 9th) it was so much decomposed, that he was led to believe the deceased had been dead at least four or five days. The face and neck were black, and decomposition had gone on to such a degree in these parts, as to obliterate, it was believed, any marks of violence that might have been there at the time of

death. The right eye was protruded—the tongue projected between the teeth to about half an inch: the ears were black, the lips were swollen, and the fingers were contracted. There was a frothy liquid issuing from the mouth and nostrils in bubbles, and living larvæ were seen in these parts. The whole of the body was greatly swollen, discoloured, and passing rapidly into a state of decomposition. When first seen, deceased was lying on his face. There was a faint, heavy smell in the room. An inspection made the next day revealed the fact that putrefaction had taken place in all parts: but the head and neck were most decomposed—the black colour of the skin appeared to decline as it got down to the lower part of the neck. Internally the heart was empty, and the vessels of the brain were perfectly empty: the blood was fluid. Fæculent matter had been discharged from the bowels before death.

There were two medical questions in this case, on which the guilt of the prisoner rested: 1. When did the deceased die? and, 2. Was death to be ascribed to violent or natural causes? On Friday, July 1, eight days before his body was found, deceased had retired to his bedroom with his wife, and during that time a large quantity of spirits had been taken to the room and consumed by him, by his wife, or by both together. On Sunday, the 3rd, the voice of deceased was heard, as if he and his wife were quarrelling. On Monday they were not seen: on Tuesday (July 5th), a man-servant deposed that he was called upstairs by the deceased, who spoke to him, and gave him half-a-crown to fetch whisky. He then heard deceased's voice, and saw his bare arm through the partly-opened door; but from the position in which he was placed, he could not see the whole of deceased's body. After this date, deceased was neither seen nor heard—he was found dead on the evening of Saturday (July 9th), his body being then in the highly-decomposed state above described. On Wednesday (July 6th), prisoner left the bedroom for a short time, and closed the door. On Thursday (July 7th), and Friday (July 8th), she was seen at the door of the bedroom by the man-servant, and on the latter day by her maid-servant, and she was then quite sober, and spoke to them as usual. On Saturday (July 9th), at ten o'clock in the morning, she ordered the servant to bring up *two* cups of tea. Between six and eight o'clock on the evening of that day, she suddenly called to one of her sons, to turn the deceased on his back. On entering the bedroom, he found deceased dead, and his body as above described. As the prisoner had been in the bedroom alone with the deceased, either living or dead, from the Tuesday when he was last seen, until the Saturday, she must, it was alleged, have been cognizant of his death, if it had not been directly caused by some act on her part. The prisoner made two statements: first, that she slept in the bed on Thursday and Friday, and that deceased died on Friday. She subsequently stated that he died on Saturday, the day on which the body was discovered.

From the state of decomposition of the body, two of the medical witnesses for the prosecution assigned a period of at least four or five days, during which deceased must have been dead. Two declined to give an opinion as to the number of days, and one, the late Dr. Geoghegan, stated his belief that such changes might take place in from twenty-eight to thirty hours. A medical witness called for the defence deposed that he had seen a body as much decomposed twenty-four hours after death. On referring to cases elsewhere related, it will be perceived that the shorter period assigned by these two witnesses, one for the prosecution and the other for the defence, is quite within the limits assigned by experience, although instances of such rapid putrefaction are not common. In this case, however, it must be remembered that the dead body was shut up in a close room, at the hottest period of the year, and the circumstances were therefore most favourable to

the process. Admitting that this was an exceptional instance of rapid decomposition, the changes described by the witnesses might have occurred within twenty hours of the time at which the body was discovered, thus carrying the death to the night of Friday the 8th, at the time when prisoner was, according to her statement, in bed with the deceased.

The other question, as to the cause of death, gave rise to a conflict of opinion. On the one hand, it was alleged that the appearances in the body, *i.e.* the black and decomposed condition of the head and neck, compared with other parts, the protrusion of one eye from its socket, and the projection of the tongue between the lips, as well as the absence of any natural cause of death, were medical proofs that deceased had died by strangulation and not by any disease or accident. On the other hand it was asserted that the deceased might have been accidentally suffocated while helplessly intoxicated, by falling with his mouth on the pillow, or that he might have been carried off by a sudden attack of apoplexy or epilepsy. The discolouration of the face, the protrusion of the eye and tongue, and the discharge of fæces, might be accounted for by his dying during a convulsive struggle; while the two supposed indications of strangling afforded by the eye and tongue, might be simply the result of the advanced state of decomposition in which the body was found. All the witnesses were agreed, that there were no marks on the neck to indicate death by strangulation; but this want of physical evidence was accounted for by some of them, on the theory that all such marks would be completely obliterated by putrefaction. The heart contained no blood, and the vessels of the brain were empty, the blood in the body was fluid and dark-coloured. The state of the lungs is not mentioned, nor the condition of the larynx and air-passages, so that it is left uncertain whether any mechanical cause of obstruction existed in these parts. The emptiness of the heart, which was adverse to the theory of death by strangulation (asphyxia), was referred to the mechanical effect of gaseous putrefaction on the organ. The emptiness of the brain was left unexplained. It was inferred by most of the witnesses for the prosecution, that the marks of manual strangulation on the neck externally, and the usual appearances of asphyxia internally, had existed at the time of death, and that these appearances had been destroyed by putrefaction. Those who adopted this view, contended that the protruded eye and tongue were conditions which had resulted from strangulation alone, and that they could not be produced or removed by rapid putrefaction.

The guilt of the prisoner rested chiefly on these two points. The facts showed, even allowing no more than twenty hours to have elapsed between death and the discovery of the body, the prisoner must have been cognizant of the death; and, unless hopelessly insensible from drink, which appears to have been disproved by the evidence, she would, it was suggested, if innocent, have given an alarm. She ultimately called to her son, and no reason can be assigned why she did not call for assistance earlier. It was impossible to assume that she was speculating on the rapid decomposition of the body, and watching for the stage when marks of violence would be obliterated. No motive could be assigned for the murder, nor for her remaining shut up in the same room with her husband, as it was alleged, for four or five days. Under these circumstances, with the admission by some of the scientific witnesses, that the protrusion of the eye and tongue might have been caused by putrefaction, the jury returned a verdict of not guilty. There was nothing to exclude the supposition that the deceased might have died in a convulsive fit from epilepsy, as a result of excessive drinking. In any case, it was obvious that the body had undergone rapid putrefaction. The greater decomposition observed in the head and neck might have arisen from the congestion of blood in the superficial vessels. As other causes besides manual violence

may produce a congestion of the head and neck, the blackening of these parts in a highly-decomposed body furnished no medical evidence of homicide. The protrusion of the eye and tongue did not strengthen the theory of strangulation, since it was properly admitted by some of the medical witnesses that these conditions were consistent with the effects of putrefaction in an advanced stage. There was, therefore, no evidence of a medical nature to show that deceased had died by violence; and, instead of drawing the inference that such evidence had existed and had been destroyed by putrefaction, it would have been safer to have said that the highly decomposed state of the body prevented any correct medical opinion from being formed. No opinion went the length of affirming that death was necessarily produced by violence; and the jury were properly informed by the learned judge (Baron Pennefather) that they were not to convict the prisoner on probability, however strong, or on a mere preponderance of medical opinion.

The medical evidence at this trial raised the question whether a protrusion of the eye and tongue in a highly-decomposed state of the head and neck should or should not be regarded as an absolute proof of homicidal violence applied to the neck. One of the scientific witnesses affirmed that these states could not result from putrefaction. Another deposed that they might result from gaseous decomposition taking place in the orbit; the gases thus confined would cause a projection of the eye and its coverings, while, in reference to the tongue, the effect might be aided by the face being inclined downwards, and the mouth being partly open. The fact that only *one* eye was protruded, does not appear reconcilable with the effect of mechanical pressure on the neck, while it would admit of explanation by the theory that decomposition took place from effusion of blood or other causes more in one orbit that in the other. With regard to the tongue, whatever causes congestion of the head and neck, is likely to cause congestion of this organ; and putrefaction, by the production of gas in its substance, may lead to its enlargement and protusion.

It is strange that the protrusion of the eye as a result of putrefaction should have been doubted and even denied, by some of the witnesses at this trial. So conflicting was the evidence regarding this appearance, that the late Dr. Geoghegan made it a subject of experiment on the dead body of a child, and he observed that the eyes protruded, as a result of decomposition, on the eighth day; they began to present the appearance of protrusion on the fourth day. A case of rapid putrefaction, in which both eyes protruded as early as sixteen hours after death, was reported by me in the 'Medical Gazette' for January, 1850 (vol. 10, N.S. p. 17). The time at which such an appearance may present itself after death, must obviously depend on the period at which gaseous putrefaction takes place in the orbits. Although, in the dead, the eyes are usually collapsed owing to transudation of the fluids, yet it has been pointed out by Orfila, that the lids may bulge forwards and the eyes protrude, from the production of gases within the cranium and orbits.

Events frequently repeat themselves in medical jurisprudence, and the same medical theories are again brought into conflict under similar circumstances. In December 1863, a trial took place at the Kingston Assizes before Baron Pigott, involving questions almost identical with those which arose at the trial of Mrs. Byrne, at Dublin, in 1842 (*Reg.* v. *Mahaig*, Kingston Winter Assizes, 1863). On this occasion the body of a woman was found dead in a room in an advanced state of putrefaction. The deceased and her lover, a soldier, had retired to a bedroom some days before, and had kept themselves there secluded: the soldier was found with his throat severely cut. This man was charged with the murder of the deceased, by strangling her with a rope, and the medical questions to be solved were: How long had

she been dead? and, Did she die from strangulation, or any other cause? At the request of the Secretary of State, I attended the inquest and the trial on the part of the Crown, having made an analysis of the stomach in order to determine whether poison was present therein. Taking the two questions in their order, it may be observed that the medical evidence showed, that when the deceased was first discovered, on Friday, November 6th, at 6.30 A.M., she was lying on her back in bed, her body being covered with clothes as usual, the head and neck only being exposed. There was a pillow lying loosely over the face. There was no rigidity, and the hands were not clenched. The upper part of the body, including head, neck, and shoulders, was very much decomposed. The skin of the face was so black that the features could not be described. The tongue was protruded and swollen. The lips were everted and blown up with gas. Gases escaped from between the tongue and lips with a slight hissing sound. The abdomen was enormously distended with gas, and at the lower part much discoloured. On opening the cavity the intestines protruded. The liver was in a putrefied state. On cutting into the skin of the chest a large quantity of air escaped; the lungs were found collapsed, and the heart was empty and contracted. Owing to the putrefied condition of the body the head was not examined. From the blackened and decomposed state of the upper part of the body, the medical witness formed the opinion that death had been caused by violence, and he inferred that deceased must have been dead for some time.

According to the evidence, the prisoner and deceased took the bedroom as a lodging at a public-house on Tuesday, November 3. The deceased was seen on that night about nine o'clock, as well as the following morning, Wednesday, November 4. On the last occasion the landlady, who took the breakfast to the door of the room, saw her face in bed. She was lying still, and, as she did not speak, the witness could not say whether she was then living or dead. It was observed, however, that of the breakfasts taken up, which had been ordered for two the previous evening, only one was eaten. From that time deceased was not seen alive. The prisoner came down stairs on Thursday morning, November 5, at nine o'clock. There was nothing unusual in his appearance or manner. He asked to borrow a razor to shave himself, but there was no razor in the house. Breakfasts were not taken up that morning; and the following morning, Friday, November 6, as neither appeared, the room was entered, and the body of deceased was then found in the state described. The prisoner was lying on the bed with his throat severely cut: the wound had obviously been inflicted some hours, and had bled a great deal.

From the time deceased was last seen living (on Tuesday night), about sixty hours had elapsed. Considering that the weather was close and damp, and the body shut up in a small room, there was ample time for the putrefactive changes described to have taken place; although such a degree of putrefaction is rarely seen until after the lapse of three or four days in warm damp weather. It was therefore an exceptional instance of rapid decomposition, like those elsewhere described. As the prisoner alone was in the room with the deceased, he must have been cognizant of her death; and yet he gave no alarm. His statement was, that they had both resolved to die; that they had purchased poison on Tuesday, the 3rd, and took it on the evening of that day, and that deceased died in his arms. In the afternoon, having left the room for a short time, he found on his return a cord round her neck, which he removed. The highly-decomposed condition of the body was consistent with his statements; for although one day might be sufficient for such changes, they are seldom witnessed in less than two days. This would place the death of the deceased on the night of Tuesday.

The main question, however, was this: Had the deceased been strangled by the prisoner on that night, or did she die from any other cause? The putrefied condition of the body was consistent with either hypothesis, and it was a strong circumstance against him that he had remained in the room with the dead body. There was, however, an entire absence of motive for the alleged murder. The prisoner and deceased had been apparently happy together. No quarrelling or struggling was heard at any time by the people of the house. There were no marks of violence on her person indicative of struggling or resistance. It was proved, as prisoner had stated, that the deceased had, on the 3rd November, purchased at a druggist's, under a false pretence, a threepenny packet of Butler's vermin-killer. This contains about one grain of strychnia, mixed with soot and flour; and the paper wrapper of this packet, with the empty bag which had contained the poison, was found in the prisoner's possession. Several letters written by the prisoner, one apparently at the dictation or with the cognizance of deceased, referred to their mutual intention to destroy themselves; and another, dated November 4, stated that deceased had taken poison and had died in his arms. With these facts there was strong reason to believe that the deceased had really taken the poison which she herself had purchased, and had died from its effects. Assuming that muscular irritability had been exhausted by violent tetanic convulsions before death, and that the deceased had died in one of these convulsive fits with great congestion of the head, the rapid putrefaction and the blackening of the features from the decomposed blood in the vessels, would then be explained. The empty and contracted state of the heart was also consistent with this view. The stomach was examined chemically by the medical gentleman who was first called in to see the deceased. He found it empty, containing only mucus with some black particles, the nature of which could not be defined. It was at first thought that it contained strychnia, but on making an analysis of the remainder of the stomach, and the spirit in which it had been preserved, I found that it contained no strychnia, and that the chemical results which had led to this conclusion were owing to the colouring action of sulphuric acid on bichromate of potash in contact with organic matter. In the state in which the stomach was brought to me, cut into two portions and macerated in spirit, it was impossible to determine whether it had originally contained starch or soot (the substances with which the strychnia in the purchased powder was mixed), or gin (the liquid in which the prisoner said the deceased had taken the poison). This negative result did not show that the deceased could not have died from the effects of a small dose of strychnia (half a grain) such as would be contained in one half of the packet which she purchased: for such a quantity might have been readily removed by absorption, especially as the poison was taken on an empty stomach. The theory adopted by the medical gentlemen who examined the body, was that deceased had probably taken strychnia, but that, before the poison had had time to operate fatally, she had been strangled by the prisoner by means of a rope placed round her neck. This, in their judgment, would account for the contracted and empty state of the heart and lungs: they assumed that as the strychnia was in the system, it would prevent that accumulation of blood in these organs which is considered to be characteristic of death by asphyxia. Another suggestion was, that assuming strychnia not to have been taken by deceased, the empty condition of the heart and lungs might be accounted for by the effect of gaseous putrefaction in the abdomen. A few ounces of bloody serum were found in the cavity of the chest, but no blood was present in the heart or great vessels connected with it.

As the head was not examined, and the internal appearances of the chest did not support the theory of death by strangulation, it was sought to esta-

blish this view by the external appearances. Here, however, the same difficulty arose as in the preceding case. The advanced state of decomposition in the head and neck rendered the medical conclusions, to say the least, unsafe. The facts relied upon, to show that deceased had died from strangulation, were, 1. The black and decomposed state of the head and neck, compared with other parts of the body. 2 Certain marks found on the neck, at the upper part, and chiefly on the left side. 3. The peculiarly moist condition of the head and upper part of the neck, and the dryer appearance of the lower part, near the chest. 4. The enormous distension of the head, and the protrusion of the tongue between the lips.

The first and third reasons assigned indicate, not the cause of death, whether by violence, disease, or poison, but simply an advanced stage of the putrefactive process, in a case in which death had taken place suddenly, and the conditions were favourable to putrefaction. The surgeon who first inspected the body, found, on the day following its discovery, three marks on the neck, corresponding to three similar marks at the back part. There was no abrasion of the cuticle in front, nor any indentation or depression, but at the back, the cuticle was peeling off as the result of putrefaction, and serum exuded from it. On removing the integuments there was no appearance of escape or coagulation of blood beneath; and this is generally found in death from strangulation. The cellular tissue was much blown up with air (the gases of putrefaction). At the adjourned inquest before the coroner, while the facts were recent, the witness had thus described the appearances on the neck: 'On the external surface of the neck, there were two or three *indistinct* marks, most distinct on the left side. On removing the skin, there was not the least escape of blood, but here and there the muscular tissue was more discoloured than the remainder.' Another witness, associated with this gentleman, who saw the body twenty-four hours later, described the marks as consisting of two or three lines of dark discolouration. There were no signs of violence beneath the marks, but the structures were of a darker colour below. He further stated that there was much blood beneath the skin from the chin to the chest; and on the arms there were apple-green streaks from putrefaction in the course of the blood-vessels. The protrusion of the tongue was referred by both, not to putrefaction, but to mechanical pressure on the neck as a result of strangulation.

A long clothes-line was found in the room, under the bed. This was proved to belong to the landlady, who stated that it had been lying a long time in the room before it was let to the prisoner and deceased. On it was one small spot of coagulated blood, as if from a wound, and some long female hairs. When these were compared with some taken from deceased's head, there was found to be no resemblance. It was suggested for the prosecution, that this rope had been employed by the prisoner as the instrument of murder.

My evidence on this part of the case, the cause of death, was to the effect that, as the deceased was not seen in the act of dying, any medical opinion of the cause of death must be speculative; that there was nothing inconsistent with death from strychnia as alleged by the prisoner, while there were no medical facts on which the hypothesis of death from strangulation could be safely based. The internal appearances, so far as they were observed, were more consistent with death from strychnia, than with death from strangulation, a fact admitted by the two medical gentlemen who ascribed death to homicidal strangulation; that the non-detection of strychnia in the body was not inconsistent with the fact that a small but fatal dose had been taken by deceased; that a rigid state of the limbs in a dead body would not be found where putrefaction had advanced to such a degree as in this case. Further, the external appearances did not prove that violence sufficient to

cause death by strangulation had been applied to the neck of the deceased. The marks of discolouration on the neck, with the protrusion of the tongue, might have arisen from extreme putrefactive changes. Had they been produced by the application of a cord, such a degree of violence as would have caused the tongue to protrude would have produced indentation and depression of the soft parts of the neck, with an effusion of blood in the course of the depression, and a ruffling or abrasion of the skin. There was no protrusion of the eyes; the tongue was not indented or bitten by the teeth, and the hands were not clenched as in death by violent strangulation.

It was suggested by counsel that strangulation might have been produced by other and less violent means than by the use of the rope, and the slight appearances thereby produced might have been obliterated by putrefaction. It was admitted that this might happen, but there were no medical facts on which such an opinion could be based. The appearances were all consistent with putrefaction in an advanced stage, without resorting to the assumption that any violence whatever, sufficient to cause death, had been done to the neck. In the defence, it was urged that the prisoner and deceased had agreed jointly to take away their own lives: this was proved by the letters and their conduct. Deceased herself had purchased poison for this purpose, and had taken it, according to the prisoner's statement, on the evening of the day on which she procured it. Everything in the case was consistent with the theory of voluntary suicide, and of an attempted suicide by the prisoner in a state of despair. The powder containing the poison had disappeared, while the paper bag in which it was sold remained.

In his charge to the jury, the learned judge observed that the great question for them to decide, was whether the prisoner had any part in the death of the deceased. If they were of opinion that her death was caused by the rope, and by his act, then their verdict must of course be wilful murder. If they thought that death was caused by poison, then they would have to consider whether the deceased took the poison without any participation on his part, in aiding and abetting her act, and if she did, then they must acquit him. But if, in their judgment, the two agreed together to take poison, and took it together, and she died, and he survived, then their verdict must be also wilful murder. The jury adopted this view, and found that the prisoner was guilty as an accessory before the fact, *i.e.* that he was not guilty of murder by strangulation, but that he aided and abetted deceased in the voluntary act of self-murder.

The two medical gentlemen, while expressing their strong belief that death had been caused by strangulation, very properly admitted in cross-examination, that they would not swear that deceased had not died from strychnia or some other cause; and one of them stated that his reason for thinking that strychnia had not caused death was, none could be detected in the body. This, of course, was equivalent to affirming that unless some portion of an alkaloidal poison, whatever the quantity taken, remains unabsorbed in the stomach, death could not be ascribed to poison. This is not consistent with experience in such matters, and so far as this particular case is concerned, could not in the least degree affect the question whether deceased had or had not died from strangulation. It is obvious that a person may take a dose of strychnia, and yet, by the act of another, die from strangulation before the poison has been wholly absorbed, or before a quantity sufficient to cause death has penetrated into the blood. The discovery of some portion of strychnia in the stomach would not prove that the deceased had not been strangled, and its non-discovery, therefore, could not be taken as a fact in favour of death from strangulation. In short, this form of violent death should be clearly and conclusively established by medical facts, independently of the administration of

poison. Here the cause of death was simply based on medical belief or probability; not on absolute certainty, which alone would justify a jury in coming to the conclusion that murder had been thus deliberately perpetrated. According to the prisoner's statement, the rope was really around the neck of the woman on Tuesday night, and he removed it. Assuming that the coloured marks on the neck arose from mechanical pressure, and not from putrefaction, it becomes a question whether the rope may not have been thus used by deceased, in attempting to strangle herself, or by the prisoner in aiding and abetting her in the attempt. Such a degree of pressure might be made on the part of the neck where those marks were found, without causing death, and this would account for their presence, without rendering it necessary to suppose that murder by strangulation had been actually perpetrated. The description does not convey the idea that it was impossible for deceased thus to have produced them, or that they could not have been produced without necessarily causing death; and thus there was literally nothing to support the hypothesis of murder but medical conjecture.

It was stated in evidence, by one of the medical gentlemen, that if strychnia had been taken and death was subsequently caused by strangulation, this fact would account for the absence of the usual appearances of asphyxia in the heart and lungs, *i.e.* that strychnia would operate by producing a contracted and empty state of the heart. Some questions on this point were put to me by the learned judge, in answer to which, I stated that no case of this compound character had, so far as I knew, occurred, or been recorded; but that on general medical principles, if, after taking poison, a person underwent strangulation, there was no reason, *quoad* the poison, why the usual appearances of strangulation should not be found in the heart and lungs. The poison being in the body, would not prevent the appearances which attend a sudden form of violent death; and although a contracted and empty state of the heart may be found in numerous cases besides death from strychnia, it is reasonable to infer that if the action of the poison had proceeded so far as to cause the emptiness and contraction of the organ, it had gone far enough to cause death, thus rendering it unnecessary to resort to any other hypothesis. From all the facts of this case, it is in the highest degree probable that deceased took a portion of the powder containing strychnia on Tuesday evening, November 3, and that she died from its effects in the course of the night; that when her body was found, she had been dead more than two days; that the prisoner aided and abetted her in the act of self-murder; that he was cognizant of her death, and was for at least two days in the room with her dead body, without giving any alarm or calling for assistance; that he may or may not have taken part of the powder, but that in accordance with their mutually expressed intentions, he had attempted to destroy himself by inflicting a serious wound in his own throat. The wound was not of that slight nature which is observed in wounds self-inflicted for the purpose of concealing or masking crime. He had lost much blood, and was depressed and faint when found.

These cases will serve to show that the changes produced by putrefaction in a dead body may often involve questions of life and death, and that they require more attention from the medical profession than they have hitherto received. In alleged child-murder it has been generally considered that a highly putrefied state of the lungs prevents a correct medical opinion being formed of their actual condition at birth; and there are few who would venture to infer from experiments on such lungs, that a child had breathed after its birth. In reference to poisoning, when, in any suspected case, the mucous membrane of the stomach and bowels has undergone extensive

changes from putrefaction, it would be unsafe to rely upon the appearances as evidence of death from poison, although they might at first sight resemble those produced by irritants. The same caution should be observed in forming an opinon from the state of the skin when putrefaction is far advanced. The discolourations which here take place, especially in parts of the body in which the venous trunks and capillaries are congested from any cause at the time of death, are liable to deceive the examiner when death is attributed to violence, and he is searching for proofs of this. In another place (page 90) I have quoted several cases of this description, and in one, according to the statement of Sir R. Christison, a man appears to have been wrongly convicted of murder by strangulation, chiefly because a broad blue mark was found in the front of the neck of the deceased. This was at first attributed to violence. There seems, however, to have been little doubt that it was due to post-mortem changes in the body.

Putrefaction, unless advanced to the last stage, cannot entirely destroy marks of violence when attended by physical injury to parts, such as abrasions or lacerations of the skin, laceration or crushing of the muscles with fracture of the trachea or larynx, protrusion of the tongue, accompanied by marks of indentation or laceration by the teeth. In such cases, a safe medical opinion may be formed in spite of the decomposed state of parts; but it is otherwise with superficial marks unattended with mechanical injury. These are precisely the appearances which occasion mistakes, as they may be really due to post-mortem changes, and not to violence. It is quite true that life may be destroyed by a slight degree of mechanical pressure, and the injury thus occasioned may be masked or obliterated by putrefaction. There is, however, this conclusion to be drawn: it is far better that a few cases of real homicidal violence should thus escape recognition, than that we should incur the serious risk of involving an innocent person in a charge which on conviction might lead to capital punishment. Murder by strangulation is murder in its worst and most aggravated form. The act itself implies malice and deliberate design. If the body is not decomposed, we may act safely: if decomposition has advanced to a great degree, whether generally or locally, it would be unsafe to base an opinion on superficial discolourations.

3. Putrefaction in Water.—The process here takes place more slowly than in the atmosphere, owing to the low temperature, and the free access of air being cut off. The skin covering the palms of the hands and the soles of the feet is found thickened, white, and sodden from imbibition, when the body has remained several days in water. Owing to this cause, ecchymoses, resulting from violence during life, are not always apparent in a body recently removed from water; it is only when the skin has lost the greater part of the water by evaporation that ecchymoses and other marks of violence begin to show themselves. The influence of air upon the skin of a body, which has been for some days submerged, is chiefly seen, after its removal from water, in the face and chest. In a few hours, if the temperature of the atmosphere be moderately high, the face will commonly be found bloated, and either livid or black. The features are so distorted, that they cannot be recognized by those who knew the person during life. The change chiefly consists in the skin becoming first of a livid brown colour, and afterwards passing to a deep green. According to Briand, when putrefaction takes place in bodies which have been lying in water, the discolouration of the skin is first seen in the face and lower part of the neck. It then spreads successively over the shoulders, chest, and legs. In bodies exposed to air, the discolouration is first seen in the abdomen, and thence spreads to the chest, neck, face, and upper and lower limbs. These discolourations are chiefly apparent in those parts

which are freely exposed to the atmosphere. They are not commonly found on surfaces which have been in close contact, as in the armpits and upper and lower limbs, where the former have been closely applied to the sides of the body, and the latter have remained in close proximity to each other. For the same reason the discolourations are not commonly met with at the back of the body, or on those parts which have been closely wrapped in clothes.

Gaseous putrefaction takes place in bodies immersed in water, as well as in those which are exposed to air. The abdomen, chest, and cellular membrane beneath the skin are thereby distended: the body acquires buoyancy and rises to the surface. It requires but a very slight expansion of the cavity of the abdomen for this effect to follow, since the human body is only slightly heavier than its bulk of water. The position in which a dead human body floats is commonly with the abdomen or back on the surface, and the head with the upper and lower extremities depending. The bodies of females, it is said, are more commonly found floating with the abdomen upwards. The period of time required for a body to rise to the surface, from gaseous putrefaction, must depend on many circumstances. It is stated to happen usually from the third to the fifth day after death from submersion. The gases may be then liberated and the body will sink; they may be again generated and it will rise. The facts connected with the buoyancy of the dead body became of great importance in the trial of *Spencer Cowper* (1699), for the alleged murder of a woman. (See Drowning.) If the dead body has been submerged for some weeks or months, or has remained long exposed before inspection, the skin will be found of a deep blue, black, or green colour, the muscles soft and discoloured, or the fatty parts may have been converted into adipocere. Ultimately the soft parts will be washed from the bones and the skeleton separated.

The changes from putrefaction, even when comparatively slight, may, as Casper justly remarks, seriously affect the value of medical evidence. The blood becomes decomposed, acquires a darker colour, and produces congestions in the brain, lungs, right side of the heart, and other parts of the body, so as to render it difficult to form a conclusion on death from apoplexy or asphyxia. ('Gerichtliche Leichen-Oeffnungen,' vol. i. p. 89.)

The special researches on drowning made by Casper and Kanzler show that putrefaction of the bodies of the drowned generally commences at the upper part and extends downwards. Thus, after a few days, while the lower part of the body may be in a tolerably fresh condition, the face, head, neck, and upper part of the chest may present a reddish colour passing into patches of a blueish-green, first seen on the temples, ears, and nape of the neck, thence spreading to the face, and afterwards to the throat and chest. These changes may be observed in summer, when a body has remained in water from eight to twelve days, and in winter for a still longer period. The head of a drowned person is sometimes much discoloured from putrefaction, when the rest of the body is in its ordinary condition. (Casper considers that this inverted order of the putrefactive process may be taken as a strong indication of death from drowning ('Ger. Leich.-Oeff.' vol. ii. p. 103); but while it may be admitted that attention should be given to this circumstance, it yet remains to be proved whether a dead body thrown into water (when death has taken place from asphyxia by suffocation or strangulation) would not undergo decomposition in a precisely similar manner.) It is worthy of remark that the uterus resists decomposition more than other internal organs. In a case in which the body of a female, who had been missing nine months, was found and examined, although all the other organs were completely decomposed, the uterus was firm in structure, of a reddish colour, and its parts were recognizable, so that Casper, who conducted the inspection, was able to affirm

that the female was not pregnant at the time of her death. ('Ger. Leich-Oeff.' vol. i. p. 93.)

Attempts have been made by the aid of baths of chlorine, salt, and hydrochloric acid, as well as by injections of chlorine, chloride of zinc, and sesquichloride of iron, so to restore the features of a drowned body as to enable persons to identify it. ('Lancet,' May 16, 1863, p. 551.) After the occurrence of such changes from putrefaction in the drowned as those above described, it would be hopeless to attempt to restore the expression of the features of the living man. It is one thing to arrest or prevent putrefaction by these agents, but another to suppose that the chemical changes can be reversed, and the corpse put in the position of a body recently drowned. It may be well to state in this place that great mistakes have been frequently made by persons relying upon the features as proofs of identity in the drowned. A singular case of this kind came before V.-C. Wood, in March 1866. (*Holliss* v. *Turner*.) The plaintiffs instituted this suit in order to establish the death of one William Turner. This person was of restless, unsettled habits, wandering about the country, and in a state of great mental and bodily depression. The last time he was seen alive was on May 7, 1865. He walked into the house of some people at Guildford, named Waller. He was shivering with ague, covered with boils and sores, with a fortnight's unshaven beard. His sores were dressed with rags. On the following day he left the place, and was never again seen alive. On May 17 (ten days after his disappearance) the body of a man much decomposed was found in the river Wey, near Guildford. An inquest was held on it the same day, but it was claimed by two men, named Etherington, as the body of their father, who was missing. Mrs. Waller and others saw the body, and stated their conviction that it was the body of William Turner. The body, however, was buried as that of Philip Etherington, a ragged piece of neckerchief having been previously removed from the neck. Some months afterwards, Mr. Etherington, sen., the supposed deceased, walked into his daughter's house. It was therefore clear that the sons, in swearing to the identity of their father, must have been deceived. There was no doubt that this was the body of William Turner. A fragment of an old neckerchief, found under the bed where this man slept on May 7, corresponded exactly with that which was removed from the neck; and further, it was remembered that there were sores on the body, which had been dressed. The Vice-Chancellor held that the evidence adduced was sufficient to identify the body found in the river Wey as that of William Turner, and made an order accordingly.

Determination of the period of death in the drowned.—Some attempts have been made to generalize on the phenomena of putrefaction in water, in order to enable us to say for how long a period a body may have been immersed. No satisfactory data, however, have been obtained to guide us in this inquiry. The changes which take place are modified in their degree and the rapidity of their progress by numerous and often inappreciable causes. M. Devergie believes that he has obtained a certain series of characters whereby he can determine with sufficient precision the length of time which a dead body may have been in the water, supposing the drowning to have occurred during the winter season. Thus, according to him, in bodies immersed *from three to five days* we shall find: cadaveric rigidity; coldness of the surface; no contraction of the muscles under the galvanic stimulus; and a white or sodden appearance of the skin of the hands. From *four to eight days*—Pliancy of all parts of the body; no muscular contractions under the galvanic stimulus; natural colour of the skin; cuticle of the palms of the hands very white. From *eight to twelve days*—The whole of the body flaccid; the cuticle of the back of the hands beginning to whiten; the skin of the face softened and pallid, differing

from the skin of other parts of the body. About *fifteen days*—The face somewhat bloated and covered with red patches; a greenish tint in the middle of the sternum; the cuticle of the hands and feet perfectly white, and becoming raised in folds. About *a month*—Face of a reddish-brown colour; eyelids and lips green; a reddish-brown patch surrounded by a green border on the fore part of the chest; the cuticle of the hands and feet white, thickened, and corrugated. About *two months*—Face brownish-coloured and swollen; the hair becoming loose; the cuticle of the hands and feet in great part detached; the nails still adherent. *Two months and a half*—Cuticle and nails of the fingers detached; that of the feet the same, but the nails still adherent. In the female there is a reddish colour of the subcutaneous cellular tissue in the cervical region, as well as that which surrounds the windpipe and the organs contained in the chest; partial saponification of the cheeks and chin, superficial in the breasts, groins, and fore part of the thighs. *Three months and a half*—Destruction of part of the scalp, eyelids, and nose; partial saponification of the face, of the upper part of the neck, and groins; destruction of the skin in different parts of the body; cuticle of the hands and feet as well as the nails entirely detached. *Four months and a half*—Almost complete saponification of the fatty part of the face, neck, groins, and fore part of the thighs; the appearance of a calcareous incrustation or deposit on the thighs; incipient saponification of the fore part of the brain; opalescent condition of nearly the whole of the skin; destruction and removal of the hairy scalp; the bones of the skull laid bare and beginning to become brittle. There are no data to give even approximative opinions for a longer period than this: and it is admitted that even these imperfect data are not available for determining the period of death in subjects drowned during spring and summer.

There is a common belief that the dead human body is soon destroyed by submersion in water; but this is not borne out by experience. In those who are drowned during winter, and whose bodies remain long below the surface, or are covered with mud so as to prevent a free access of air, decomposition takes place slowly. Mr. Eager of Guildford communicated to me a case, in which a man, æt. 70, was missing from January 6 to February 4, 1864. His body was found in a river, and there was reason to believe that he fell in and was drowned on the day he was last seen. The head, neck, and a portion of the chest, where unprotected by clothing, were thickly covered with mud. When this was removed, the features were perfectly recognisable, and although twenty-eight days had elapsed identification was easy. The only changes observed were as follows:—The cuticle peeled away from the cutis when slight friction or pressure was made over those parts which had been covered with mud. The face and neck were somewhat darkened in colour, and the front part of the chest was marked with slight lines of lividity. There was no tumefaction whatever over any part of the body. The thickened skin of the hands and feet was corrugated and whitened by long-continued maceration, but remained firmly adherent to the tissues beneath it. With these exceptions the body presented no appreciable alteration of appearance, nor any departure from that which would be observed in a recently dead body.

In 1857 I was consulted in the following case. Some parts of the body of an infant were found floating on the suface of water in a pit. There was the skull with the sodden skin upon it, but the brain, eyes, and ears had disappeared. The upper part of the chest and one arm were found. The soft parts appeared to enclose the bones, which were quite loose and discoloured, but saturated with water. Some of the articular cartilages were still attached, although very much softened and easily separated. There were the remains

of a woollen cloth in which the body was probably wrapped. It had been kept at the bottom of the water for some time by a heavy stone found there, which was no doubt attached to the body. Upon these facts the questions submitted to me, in reference to a woman delivered of a child eighteen months previously and suspected of murder, were, whether it was possible that a human body could remain so long a time as eighteen months in water, without being totally destroyed. Further, whether the action of water would not increase the bulk of the body, so as to make a new-born child appear some weeks old. The answers to these questions were:—1st. That a dead human body submerged is not necessarily destroyed in eighteen months; and in reference to this case, it appears probable from the description that the body had been immersed for a longer period. 2. That in the early stages of gaseous putrefaction, the body may appear larger from general distension; but this stage had been long passed in reference to these remains. Although this was probably a case of infanticide, there were no data to determine whether the child had been placed in the water living or dead.

Mr. Harris, of Redruth, met with a remarkable instance of the effects of water on the human body after submersion for the long period of twenty-six years. In 1828, a healthy muscular man æt. 24, fell into the shaft of a Cornish mine, fifty fathoms deep, of which thirty fathoms consisted of water. The efforts to recover the body were unsuccessful. The shaft was closed over, and so it remained until April 1854, when the working of the mine was resumed. The skeleton of the missing miner, with portions of the clothes which he wore, was discovered in one of the levels, in which there was water. The remains, as well as the clothes, buttons, and boots found on the skeleton, were identified by his brother. Mr. Harris found that all the soft parts, with the exception of a small piece of fatty substance, were destroyed, but the bones were firm and well preserved. There was no muscle, tendon, ligament, or even cartilage about any of them. They were all detached from the joints. They were of a dirty brownish or almost black colour. The skull was full of a brown soft substance, which was without smell. There was nothing in the water calculated either to destroy the soft parts or preserve the bones.

It is not often that any very precise opinion is required of a medical witness respecting the probable period at which death has taken place from drowning. A question has, however, arisen respecting the time required for the production of *adipocere* in the drowned, and on this has depended an important question relative to the presumption of survivorship. The property of a gentleman who had commited suicide by drowning, was seized under a commission, and an action was brought to recover it at the Warwick Lent Assizes, 1805, on the ground that the insolvent was dead at the time the commission was issued. The following is an outline of the case:—

The deceased, who was in a state of insolvency, left his home on the 3rd of November; and on the 12th of December following, *i. e.* five weeks and four days after his departure, his body was found floating in a river near the place where he resided. A commission of bankruptcy had been taken out against him a few days after he was first missed, and before it was known that he had destroyed himself. It became therefore important to determine whether he had drowned himself (for there was no doubt of his having committed suicide) *before* or *after* the date of issuing this commission. If it could be shown that he was already drowned when it was issued, the commission would be void in law, and his property could not be seized under it. The litigation then turned upon the question, whether he had drowned himself on the day of leaving his house, or any time afterwards. The body was found floating with the head and feet submerged. On being taken out, the face

was covered with a muddy slime. The body was discovered on a Wednesday, and a coroner's inquest was held on the following Saturday. On the Friday, the day before the inquest, three medical men examined the body with a view to ascertain whether any change had taken place in it, which could justify an opinion as to the time during which it had been lying in the water. The muscles of the buttocks were found to be converted into a fatty substance, very much resembling suet (adipocere). The face was completely disfigured by putrefaction. The hair of the head separated from the scalp by a slight pull. The other parts of the body were firm and white, without any putrefactive appearance. The clothes externally seemed unchanged in any way; but the shirt and neckcloth were so rotten as to be torn by the slightest force.

Mr. Dickenson, a medical witness for the plaintiffs, *i. e.* the relatives of deceased, stated it as his opinion that the body could not have been less than *six weeks* submerged. Three or four weeks would not have sufficed to produce the appearances met with. He thought the adipocerous state of the body could not have been brought about in *less* than six weeks. In cross-examination he admitted that he had met with an instance in which a body taken from the Severn had a spermaceti appearance within a shorter time, although the change had not advanced so far as in this instance. Dr. Bree said that the parts of the thigh and abdomen were changed into a soapy fat or adipocere. He supposed the body must have been under water for more than six weeks; he therefore thought the deceased's body must have been in the water during the whole time that he was absent. If it had been exposed to the air it would not have presented the appearances met with. In cross-examination he admitted he had said that the body was in such a state, that it would be impossible to express an opinion. Dr. Gibbes stated that he had been for many years engaged in experiments on the production of adipocere, and had published the results of these in the 'Philosophical Transactions.' He had been able to procure a small quantity of adipocere from muscle by maceration in water for *a month*; but in general, it required a much longer period for this transformation to take place. Upon this scientific evidence, the jury were of opinion that the deceased was not alive at the time the commission was taken out, but that he had been dead for the whole period of his absence, and the bankruptcy was accordingly superseded.

In medicine as in law, there are always two sides to a speculative question; and accordingly there appeared just as many medical witnesses for the defendants, *i.e.* the creditors, as for the plaintiffs. The case, *primâ facie*, as we have seen, was in favour of the plaintiffs. The state of the body supported this view, although it might have been contended for the defendants that a few days more or less would have made no difference in the results, and that deceased might therefore have been alive when the bankruptcy was declared. The verdict of the jury was physiologically well founded. The general period required for the production of adipocere in drowned bodies, is stated by most observers to vary from three or four months to a year. Its occurrence in a body to any extent, within five weeks and four days, must be regarded as an exception to an extensive series of observations. The witnesses for the plaintiff were then justified in assigning the longest possible period, that the circumstantial evidence would admit, for its production in this instance. The facts of this case show that adipocere may be produced in the body of a drowned subject within a period of six weeks. The defendants wished to make it appear that the adipocerous transformation might take place with much greater rapidity, but there were no facts to render this view probable, while there were many facts in support of the contrary opinion.

One instance of its early production is related by Dr. Harlan, of Philadelphia. He had occasion to macerate the cranium of a fat negro in the summer of 1824; it was placed in a barrel of water, and kept closely covered over. About six weeks afterwards he observed the head floating on the surface, and rather inclined on one side. The portion of the head which floated above the level of the water was tumefied, and on cutting into it, the whole substance down to the bone, was found converted into adipocere: but that portion of the head and face which was immersed in water, was in a putrescent state.

It may be as well to compare the facts of this case with the rules laid down by M. Devergie, for determining the period during which bodies have remained in water. The deceased was an adult, and the drowning took place during the winter season:—it is therefore a favourable case for testing the value of these rules. M. Devergie fixes the earliest period for the production of adipocere at about two months and a half: he then speaks of its commencing in the cheeks, chin, breast, groin, and fore part of the thighs. Here, however, in less than six weeks, the adipocerous change had taken place completely in the muscles of the lower part of the abdomen and of the buttocks. M. Devergie states that the hair of the scalp becomes loose in about two months: here it separated with the slightest pull in six weeks. The data furnished by this medical jurist, would therefore tend to assign a much longer period of submersion than six weeks, to a body presenting the characters observed in this case. It is scarcely necessary to remark that rules of this kind must be regarded as remote approximations to the truth. The late Mr. Callaway informed me that he was required to give evidence in a similar case, respecting the probable period at which drowning had taken place, from the partial conversion of a body into adipocere.

When a dead body is immersed in a liquid of a preservative nature, as in the water of a peat-bog, the changes which take place are of a peculiar kind, and they render it difficult to arrive at even an approximate conclusion respecting the period of death. In July 1858, Dr. Barry of Kanturk, Ireland, consulted me in reference to the following case. A male human skeleton was found near the surface of a peat-moss or bog. All the bones were detached, and were of a deep chocolate colour. The right femur had been accidentally fractured obliquely by an instrument used by the peasantry in cutting turf. The skin and muscles were closely adherent to it. They were free from any unpleasant odour, and were completely tanned. The bones were destitute of phosphate of lime, and in consequence were as flexible as cartilage. Dr. Barry calculated by a comparative measurement of the thigh bone, that the stature was five feet seven inches. The sex was determined as usual, by the roughness of the bones, and the size and shape of the pelvis. There were no means of determining the cause of death. The skull had not been fractured. It was supposed that the person had been shot and the body deposited in the bog ten years previously, but Dr. Barry was of opinion that it might have been lying there fifty years. The removal of the phosphate of lime was a remarkable fact; it probably depended on the action of some acid in the water. Tannic acid was, no doubt, the agent by which the soft parts were preserved.

CHAPTER 8.

IDENTITY OF MUTILATED REMAINS—CASES—EXHUMATION OF SKELETONS—HUMAN AND ANIMAL BONES—DETERMINATION OF SEX, AGE, AND PERSONAL PECULIARITIES—DETERMINATION OF AGE BY THE TEETH—QUESTIONS OF PERSONAL IDENTITY—EVIDENCE FROM FRACTURES, DISEASE, AND DEFORMITY.

Identity of mutilated Bodies.—A DEAD body partially putrefied, may be found mutilated, and parts of it may be discovered in localities distant from each other. There is less difficulty here in making out identity, than where only bones are discovered; for it is by no means easy to say whether certain bones belonged to the same skeleton or not. So long as the soft parts are attached to them, there will be no difficulty in forming an opinion. Those who commit murder, and thus dispose of a body, believe that identity must be entirely destroyed, if they only deposit the parts in remote places. In this respect, however, they are generally deceived: for satisfactory medical evidence may still be forthcoming. In the case of the woman Brown, murdered by *Greenacre* in 1837, the head, trunk, and limbs were scattered in widely distant parts of London. The limbs were not found until six weeks after the trunk, and then at a considerable distance, and under very different circumstances. In the examination of the trunk, it was observed that the fifth cervical vertebra had been sawn through, leaving only about the tenth of an inch of that bone. When the head was found it was observed that the fifth cervical vertebra had also been sawn through, leaving only the posterior spinous process. On comparing the head with the trunk they fitted exactly, even to the continuation of a superficial cut on the skin. On afterwards comparing the trunk with the legs, it was ascertained that the cut surfaces exactly corresponded. The thigh-bones remaining attached to the trunk, had been sawn through about an inch below the trochanters, to about one half of their thickness, and then broken off. When the limbs were discovered six weeks afterwards, the portions of thigh-bones found exactly corresponded in the marks produced by the saw and in the portions broken. Not only were the parts of the body thus proved to belong to one and the same woman, but the individual was further identified by the peculiarity of the absence of a uterus.

In a case of infanticide, which was the subject of a trial in 1839, the arm of a child was found concealed in a dust-hole of the house, while at about the same period, a body without an arm, and the head of a child, were found in a ditch at some distance from the house where the accused person was living. The identity was, however, distinctly made out by the fact, that the arm and scapula attached to it, fitted exactly to the trunk, and that the incisions through the muscles and vessels completely corresponded.

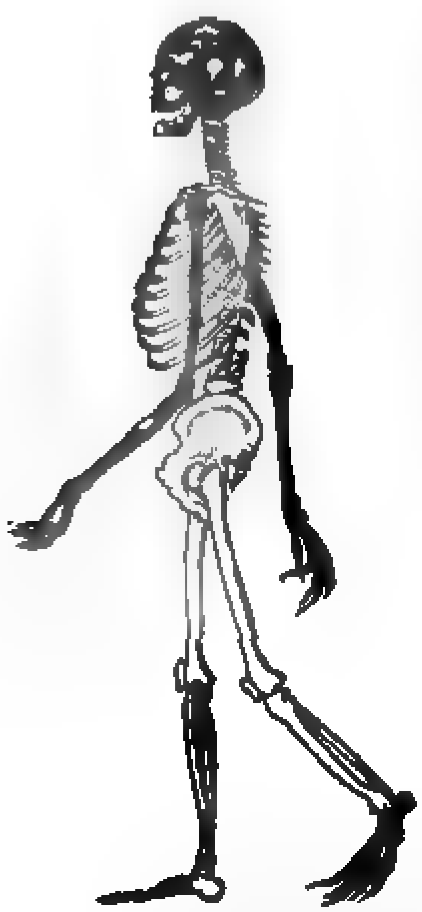
On the occasion of a murder perpetrated at Brighton some years ago, the head and subsequently the body of a female were found in different and distant places. They were clearly identified as belonging to the same individual: first, from the fact that there were four cervical vertebræ attached to the trunk and three to the head; and secondly, from the divided vessels and cartilaginous rings of the trachea exactly corresponding. The importance attached to this kind of anatomical evidence, shows that when a portion of a dead body is found, the whole of the parts which form the boundary of the section, should be attentively observed and accurately described.

The case of Dr. Parkman, for the murder of whom *Professor Webster* was tried and convicted at Boston, U.S., in March 1850, presents a remark-

able instance of the value of scientific evidence, in establishing the identity of a mutilated body. It also proves that even all the refinements of science will fail in the attempt so to dispose of a dead body in a case of murder, as to prevent its identification. On November 23, 1849, the deceased, Dr. Parkman, was traced to the laboratory of the prisoner, and from that date he was missing. A week after his disappearance, there were found concealed, in the vault of a privy belonging to the prisoner's laboratory, a pelvis (the hip-bones), the right thigh (from the hip to the knee), the left leg (from the knee to the ankle);—and with them certain towels bearing the initials of the prisoner, and being such as were used by him. Among some cinders and slag, connected with a furnace, were found portions of bones, apparently of the cranium, fragments of vertebræ, blocks of artificial teeth, and some gold which had been melted. On the day following, in a remote corner of the laboratory, there was found a tea-chest containing, imbedded in a quantity of tan and covered with minerals, the entire trunk of a human body, with the left thigh from the hip to the knee. When the parts were placed in apposition with the portions previously found, they corresponded, so that they were obviously parts of the same body. This observation also applied to the remains of bones (cranium and vertebræ) found in the slag of the furnace. There was no duplicate portion. All the fragments fitted so as to form part of the same human skeleton. The portions thus found resembled in every particular the body of Dr. Parkman, and in no single particular were they dissimilar from the body of the deceased. There were missing from these remains, when they were placed in apposition, the head, the arms with the hands, both feet, and the right leg from the knee to the ankle.

The parts found (which are light in the engraving) were accurately examined by several medical gentlemen. They deposed that they were human remains, parts of one and the same human body of the male sex; that they had not undergone dissection for anatomical purposes, and had not been submitted to any process of preservation. Further, that they had been cut and hacked in different directions without any reference to their anatomical relations, and evidently by a person only partially acquainted with the structure of the body. The chest was still covered with the muscles and skin. It was noticed, that under the left nipple, between the sixth and seventh ribs, there was an opening which penetrated into the cavity. The opening was slightly ragged, and about one and a half inches in length.

Fig. 1.



Dr. Parkman's remains restored. The missing parts are black.

It seems that Dr. Parkman was sixty years of age, and his stature was five feet eleven inches. The portions of the body thus restored, were those of a person between fifty and sixty years of age; and with respect to stature, the portions found, extending from the seventh cervical vertebra to the outer ankle (malleolus) measured 57½ inches. The distance from the sole of the foot to the outer malleolus, measured in another subject of the same age, was 3 inches; and the distance from the top of the head to the base of the sixth cervical vertebra was 10 inches. Adding these measurements to the missing portions, the total length of the body found would be 5 feet 10½ inches, being within half an

inch of the stature of Dr. Parkman. There were marks of identity about the teeth and jaws which left no doubt that the remains were those of the missing gentleman. An attempt had been made to destroy the skin and flesh of the chest, by the use of a strong solution of potash, but this had failed. The defence of the prisoner rested upon the facts that the charge was based entirely on circumstantial evidence, that the identity of the remains had not been satisfactorily made out, and that no cause of death had been proved. The jury, however, returned a verdict of guilty, and the prisoner was subsequently executed (see 'Report of the Trial of Professor Webster,' by Dr. Stone, Boston, 1850).

A singular case involving somewhat similar questions occurred in London in October 1857. I allude to the remains of a human being, found in a bag on one of the buttresses of Waterloo Bridge. It appeared that they had

Fig. 2.

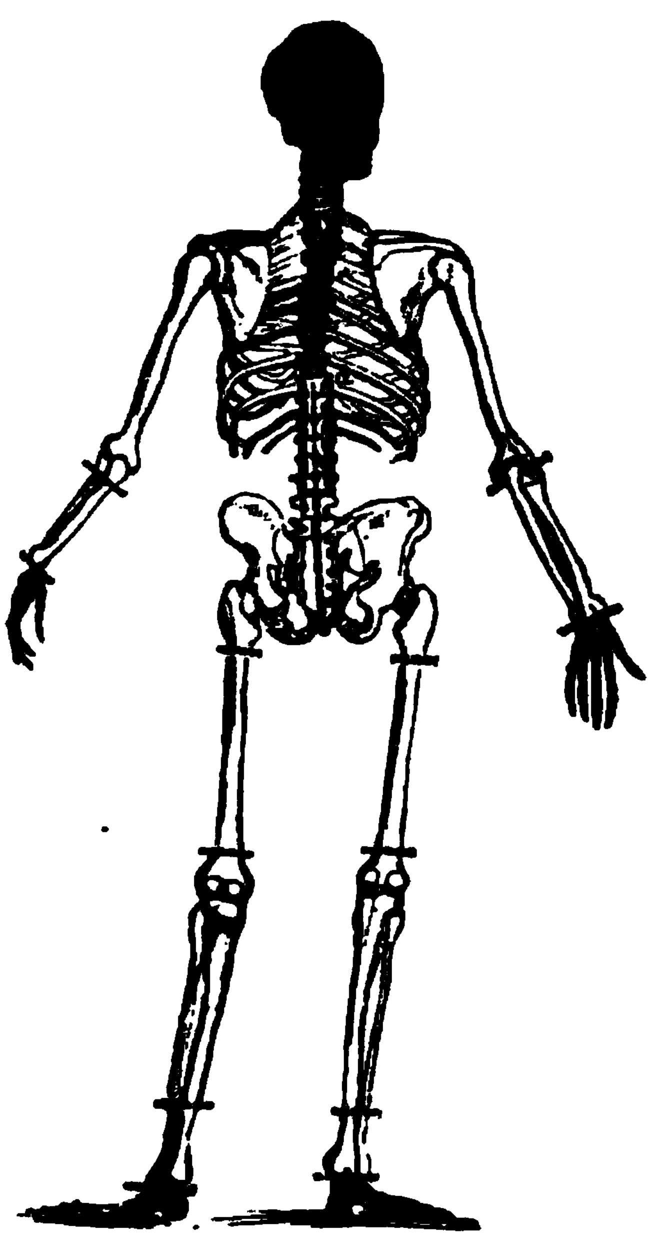
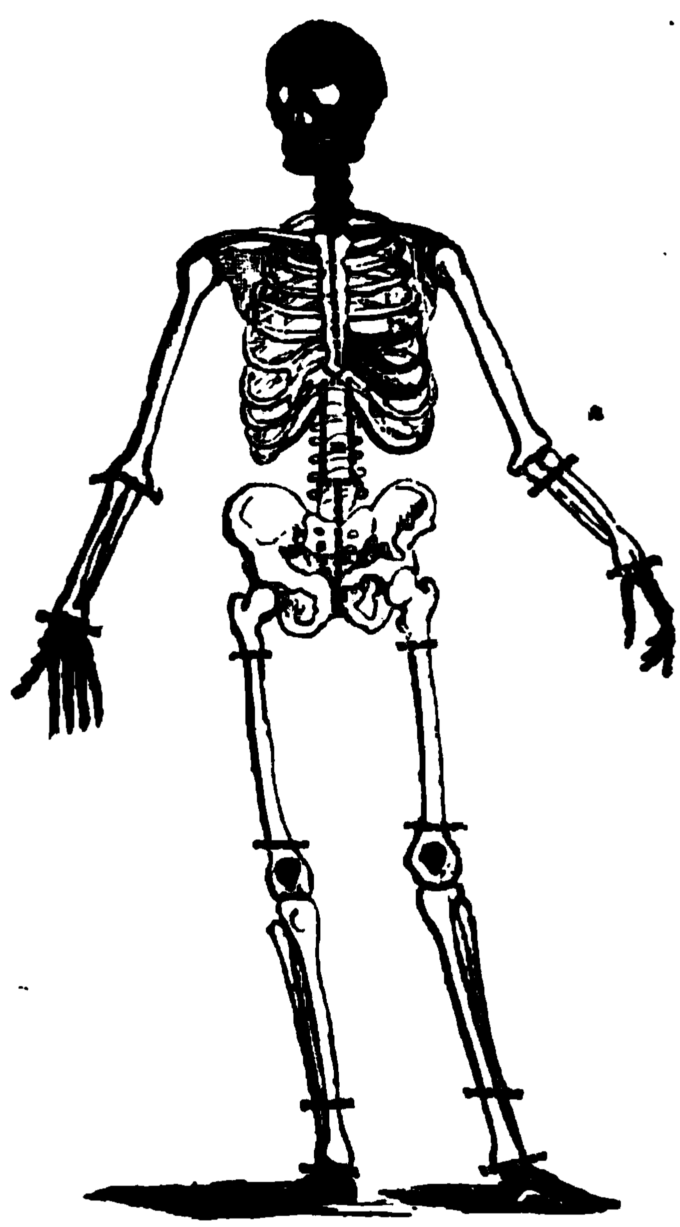


Fig. 3.



Waterloo Bridge remains restored. Front and back view of the Skeleton. Dotted lines showing where the bones were cut or sawn. Missing parts black.

been accidentally deposited there the night previously—the intention of the person who carried them being, no doubt, to lower them into the river, but by accident they lodged on one of the buttresses of the bridge. A number of articles of clothing were in the bag with the remains. By an order from the Home Office these remains were submitted to the examination of Dr. Painter, the Divisional Surgeon of Police, and myself.

We found them to consist of parts of a human body, and obviously of the same body, as, when allowance was made for the missing portions, they admitted of an accurate adjustment to each other. There were twenty-three portions of the body discovered, consisting chiefly of bones with flesh adhering to them. The flesh had been roughly cut from the bones, apparently with a view to remove as much of it as possible, and to destroy completely the identity of the body. The parts had been cut and sawn into

small lengths, probably to reduce their bulk and to allow them to be packed within a small space. The trunk, including part of the chest and spine, had been cut into eight pieces; the upper limbs had been cut or sawn into six, and the lower limbs into nine pieces. The hip and elbow-joints were in a strongly flexed condition. The missing portions, which are marked black in the engravings, were the head, with the greater part of the spine, namely fourteen out of twenty-four vertebræ (seven cervical and seven upper dorsal), the hands, the feet, and some portions of the left side of the chest. It will be observed that these were also the parts which were missing in the case of Dr. Parkman. In fact, a murderer intending to destroy personal identity, would in general most effectually succeed in his object by removing the head, feet, and hands. The whole of the viscera of the chest and abdomen had also been removed. The twenty-three fragments found weighed only eighteen pounds. This is about one-eighth part of the average weight of the adult body. The questions which required solution in this case were the following:—1. The sex, age, and stature of the deceased; 2. The presence of any physiological or pathological peculiarities in reference to personal identity; 3. The presence of any wounds or marks of violence, with reference to the probable cause of death; 4. The general condition of the remains, with a view to determine whether they were parts of a dissected body, and whether they had undergone any chemical process for the purpose of preservation; 5. The length of the period which had probably elapsed since the death of the deceased. The details of this examination will be found elsewhere ('Med. Gaz.' Oct. 31, 1857, p. 445). There was no difficulty in determining the sex of the deceased, as a portion of the sexual organs, which had been mutilated (not dissected), still remained attached to the pelvis. The long bones were in their full state of development. The stature was determined by taking the length of the portions found, and adding a certain number of inches for the missing skull, cervical vertebræ, and feet. The bones had been sawn through near the joints with a fine bone-saw, such as is used by bone-boilers. On the left side of the chest, between the third and fourth ribs, there was a stab which had penetrated the cavity, and which, if inflicted on a living person, would have been in a direction to enter the heart. The edges of this wound were everted and wide apart, and the muscles around were infiltrated with blood. It had those characteristics which are observed in wounds inflicted on a living body. In Dr. Parkman's case there was a similar wound penetrating the chest on the left side between the sixth and seventh ribs. No portion of these remains had the appearance of having undergone dissection or any preparation or use for anatomical purposes. There was no injection of blood-vessels; the muscles, vessels, and nerves had been cut through, or rather hacked in all directions, without any reference to relative position. The spinal marrow had been violently torn out of the vertebral canal, and was left hanging by its sheath to the vertebræ. The joints had been sawn through, evidently with great trouble, at points where a scalpel, even in the hands of a young anatomist, would have speedily effected the separation of the limbs. Further, no preservative of animal matter had been employed. There was no trace of arsenic, corrosive sublimate, nitre, salts of alumina or chloride of zinc, in the soft parts. Portions of the muscular fibre were brown and sodden; they presented the appearance of having been boiled in water and soaked in a solution of common salt, which was separated from them by crystallization. Portions of the skin, as well as the ligaments of the joints, had a similar appearance, *i.e.* of having been submitted to the action of boiling water. From the condition of the soft parts and joints, it appeared probable that the body had been cut up and exposed to a boiling temperature, while the members were in a state of cadaveric rigidity. We considered

that the boiling and the salting of the remains had been resorted to in order to prevent any offensive smell as a result of putrefaction, which might have led to their discovery. The interior of the right hip-joint, and the deep-seated portions of flesh around the joint, had escaped the action of salt and water; and from the condition of these parts, as well as other circumstances, we formed a conclusion respecting the probable period at which this person had died. The conclusions from the whole of the investigation were as follows:—

1. That the remains were those of a person of the male sex, of adult age, and of at least 5 feet 9 inches in stature; 2. That the parts found presented no physiological or pathological peculiarities by which they could be identified as belonging to any particular individual. The only fact observable under this head was, that the portions of skin remaining were thickly covered with dark hairs, and that the deceased was probably a dark hairy man; 3. That the remains presented no appearance of disease or of violent injury inflicted during life, with the exception of a stab in the space between the third and fourth ribs on the left side of the chest. This stab was in a situation to penetrate the heart and to cause death. It had the characters of a stab inflicted on a person, either living or only recently dead; 4. That these remains had not been dissected or used for the purposes of anatomy. All those parts of the human body which are useful to an anatomist had been roughly severed and destroyed by a person or persons quite ignorant of their anatomical relations. They had been probably cut and sawn before the rigidity of death had ceased, *i.e.* within from eighteen to twenty-four hours after death; and in this state had been partially boiled and subsequently salted (placed in brine). The body of deceased had not been laid out or attended to like that of a person dying from natural causes, whose body might be lawfully used for anatomical purposes; 5. That the person of whose body these remains were a part, may have been dead for three or four weeks prior to the date at which they were examined, namely, on October 21, 1857.

The articles of dress found with the remains in the bag were those of a man and a foreigner. They were much torn: some presented the appearance of stabs and cuts, while all were more or less stained with blood, some of the stains presenting coagula. A stab through the double-collar of an over-coat must have been inflicted with great force, as it was found to extend through corresponding parts of the under-coat and waistcoat. All these articles of dress had stains of blood on the inside, and chiefly on the left side of the body, in the parts corresponding to the stab on the left side of the chest. The cutting and tearing of the dress may have arisen from the removal of the clothes while the body was in a state of rigidity in a constrained attitude. The state of the clothes was consistent with their having been worn by the deceased when he was subjected to violence which led to his death.

From inquiries made by the police, there was reason to believe that the remains were those of a Swedish sailor from a vessel then in the river. It is believed that he met with his death by stabbing, and that after a short concealment, his body, cut up and mangled in the manner described, was disposed of by throwing it into the river. The head and other missing parts had probably been thus got rid of; and it was only by the accident of the bag lodging on a buttress of the bridge, instead of falling into the river, that these remains were found. As the deceased was most probably a foreigner whose name was not known, and of whose personal appearance no description could be given, there was no clue to the perpetrators of this murder. In this respect it resembles some murders of recent date, in which the bodies have been discovered entire.

In reference to these cases of mutilation, there is one point which requires a

brief notice. When parts of dead bodies are found, a credulous section of the public commonly adopt the hypothesis that some medical student has resorted to this method of disposing of parts of a dissected subject, in order to alarm the neighbourhood. Thus, in the case of *Greenacre*, there was a general disposition to refer the first portion of the mutilated remains which were discovered to a wanton act of this kind. The erroneousness of this view was proved only by the subsequent discovery of the corresponding parts of the dead body and the detection of the murderer. So in reference to the case of Dr. Parkman, the mutilated remains were at first described as anatomical preparations! Such an hypothesis is of course highly favourable to the escape of criminals, and is eminently prejudicial to the course of justice. It points out to the assassin an easy method of deceiving the public; and it shows that if he only mutilates a corpse by removing and destroying the head, hands, and feet, leaving the remainder of the body to be discovered accidentally, he has a far better chance of escaping detection and punishment than by attempting to conceal the entire murdered body. The Waterloo Bridge case formed no exception to the protection thus unintentionally extended by public opinion to a foul act of murder. Anyone acquainted with anatomy and the dissection of bodies would at once perceive from the description that no portion of this body could have been used for such a purpose. Medical students do not, as part of their anatomical pursuits, hack and mangle a dead body so as to destroy muscles, vessels, nerves, and spinal-marrow; they have no occasion to make away with all those parts by which a body may be identified, or to boil and salt the remainder: they do not receive corpses for dissection with their clothes, nor is there any conceivable reason why, if they did, they should produce cuts and stabs and stains of blood on the inside of the clothes with such accuracy as to correspond to the effects of wounds inflicted on a living man! It was suggested that no murderer would have secreted the clothes with the remains. It is difficult to speculate on the proper course which should be pursued by men who are fresh from the perpetration of an atrocious crime, and who are anxious to conceal it, but this may be fairly said,—the bag of clothes with the remains was lowered over the bridge with a view that it should fall into the water and be carried away by the tide: it was owing to mere accident that it was found in the situation described. The head and other parts had no doubt been already successfully disposed of by a similar proceeding.

The identity of the bodies of soldiers and sailors has been sometimes established by the existence of marks on the skin, such as anchors, stars, initials, &c., indelibly impressed in the structure by colouring matter. The presence of mothers' marks (nævi), or of scars from wounds or injuries received many years previously, and situated in particular parts of the body, have also proved the means of identification. Cicatrices from bleeding, cupping, or from vaccination, should be noticed at these examinations; also whether there are any scars or depressions in the skin indicative of small-pox.

It is not often that a question arises whether a portion of a body found is that of a human being or of an animal. In 1838 that which was at first supposed to be a human hand was found in a dust-bin in the City. It was alleged that a horrid murder had been perpetrated, and an inquiry took place at the Mansion House in reference to the supposed atrocious crime. Some doubts were raised whether the relic produced was really the hand of a human being. In order to have these doubts removed, it was sent to St. Thomas's Hospital for the inspection of the late Mr. Solly and other medical gentlemen, when it proved to be the fin or paddle of a turtle!

Exhumation of Skeletons.—It occasionally happens that medical investigations are required to be made so long after interment, that all the soft parts

of the body are destroyed, and nothing but the entire skeleton or a few bones may be discovered. In either case numerous important questions may arise affecting identity as well as the mode of death. Indications of murder or violent death may be obtained long after the entire destruction of the soft parts. Briand relates the case of a woman, whose body was disinterred in 1833, after eleven years' burial. It was believed and alleged that she had been murdered, and her body afterwards buried by her murderers. This was found completely reduced to a skeleton, but nevertheless the third, fourth, fifth, and sixth cervical vertebræ were still held together by a dark coloured mass derived from the decomposition of the fleshy parts of the neck; and this mass was still surrounded by several folds of a cord, which had been employed as the means of strangulation. Proof was thereby obtained of the mode in which the murder had been perpetrated. It was also possible to determine the length and colour of the hair, the state of the teeth, and the form and length of the bones. A ring was found on the bones of one finger, which left no doubt whatever of the identity of the deceased.

In 1829, a man named *Guérin* was condemned at the assizes at Versailles for the murder of his brother. The murder had been perpetrated on August 21, 1825, and the body had been buried in the corner of a damp cellar. The exhumation of the remains took place three years after interment, and it was ascertained by inspection that the deceased had been destroyed by blows on the cranium with a bruising instrument of large surface, and the identity of the deceased was clearly made out by the disposition of the teeth, the malformation of the vertebral column, and the curved form of the bones of the legs. All these facts were deposed to by witnesses.

The case of *Eugene Aram*, although of old date, also furnishes an instance of the necessity for closely examining skeletons when it is suspected that the individuals have died from murderous violence. This man conspired with another to murder a person named Clarke. The deceased suddenly disappeared in February 1745, and his absence could not be accounted for. In 1758, *i.e.* thirteen years after his disappearance, some bones were accidentally discovered in a cave near the town where he lived. Aram's accomplice was arrested on suspicion; and, losing his presence of mind, when charged with the murder, he denied that those were the bones, but mentioned the spot where the bones of Clarke were buried. A skeleton was there found, and the traces of a fracture and indentation of a temporal bone were plainly perceptible. The manner in which the murder was committed was confessed by the accomplice, and the medical evidence corroborated this confession. Aram, who was a man of some ability, argued in his defence that it was impossible to identify a skeleton after the lapse of thirteen years; that the fracture of the skull and the piece of bone beaten inwards proved nothing; that it might have lain long in the cave where it was found, which had been a hermitage, and therefore a likely place of sepulture in ancient times; and that the violence to the skull might have been produced in times of disorder, when, in searching for treasure, the graves and coffins of the dead were violated. He also positively denied the conclusions as to the sex of the skeleton; but this objection was entirely set aside by the medical evidence. In spite of the ingenuity of this defence, the facts were too strong against him, and he was convicted and executed.

Aram's defence throws some light upon the questions of doubt which are apt to arise when evidence is given from the examination of exhumed bones. Thus, for example, we find three points strongly urged, involving the consideration of the time required for the destruction of the skeleton, and therefore of its identity: of the form, situation, and appearance of a fracture of a bone, so as to enable a medical witness to determine whether it be of recent or of old standing, and whether it was likely to have been caused by

accident previously to or during the exhumation, or had arisen from the direct application of violence to the skull during life. Lastly, a clear determination of the sex may be required from an examination of the bones. This, of course, is material to identity, and therefore one of the first circumstances to which a medical witness should direct his attention.

Mr. Perfect has reported a case which shows the importance of attending to *sex* in exhumed skeletons. Two brothers lived together in a farm in the neighbourhood of London. The younger of the two was dissolute and irregular in his habits, so that they lived very unhappily. One winter's night, when the ground was covered with snow, the younger brother absconded from the house by letting himself down from his chamber window; and when he was missing the ensuing morning, his footsteps were clearly traced in the snow to a considerable distance, but there were no footsteps of any other person. Time passed on, and nothing was ever afterwards heard of the missing brother. The elder brother left the farm, and it passed into the hands of a stranger. During the progress of some alterations in the grounds surrounding the house, a skeleton was dug up. It was immediately conjectured that the one brother had murdered the other; an investigation was called for, and an inquest was held. Mr. Perfect, who was not summoned as a witness, requested permission to examine the bones. Having disposed them in their natural order, he found that they represented a person of short stature; and from the obliteration of the sutures of the skull, and the worn state of the crowns of the teeth, he inferred that they must have belonged to an aged person. On examining the bones of the pelvis, it was perceptible that they had belonged to a *female*. When this fact was communicated to the jury, the two medical men, who had given their opinions from a hasty examination, were sent for, and one of them immediately corroborated the statement that the skeleton had belonged to a female. The proceedings were of course at an end, and a heavy suspicion, amounting to a charge of fratricide, was thus removed from an innocent man. On further enquiry, it was ascertained that the bones had been removed from an old gravel-pit, where gipsies had been accustomed to assemble, and occasionally bury their dead.

From the examination of many reported cases in which medical evidence has been required on these occasions, I find that the circumstances to which inquiries have been especially directed are the following:—

1. Whether the bones are those of a human being, or of some animal. 2. If of a human being, whether they belonged to a male or a female. Having thus far established their identity as part of a human skeleton, some subordinate questions may arise respecting them. 3. The length of the period during which they have probably remained in the ground. 4. The probable age of the individual to whom they belonged. If the upper and lower jaws be found, we shall derive much assistance in solving this question by an examination of the teeth. 5. The probable stature of the individual when living. 6. The race to which he belonged: thus we must not confound the skeleton of the Caucasian with one of the Negro or Mongolian variety: for, from the mixed nature of our population, even this may become a material question in relation to the guilt or innocence of an accused person. We are then bound to examine these bones for certain special characters, the observation of which may be necessary to throw a light upon the general evidence; while inattention to them, or a misinterpretation of them at the time of examination, may lead to the defeat of justice, and to the censure of the medical witness. 7. It will be proper to determine whether solitary bones belong to the right or left side of the body, and whether they form parts of one, or of more than one skeleton. 8. Whether they have sustained any mechanical injury during life,

i.e. whether at any antecedent period they have or have not been fractured; and if a fracture has existed, whether this has occurred during life or by accident during the exhumation: if during life, whether it be recent or of old standing. 9. The presence or absence of personal deformities, the presence or absence of supernumerary fingers or toes, of a curvature of the spine, of a curvature of the bones from mollities ossium, or of anchylosis (union) of one or more joints. 10. Murderers sometimes attempt to make away with their victims by burning the bodies: it may be therefore proper to determine whether the bones have or have not undergone calcination. This especially applies to cases of infanticide. Sometimes but a very small portion of the fœtal skeleton can be procured for the formation of a medical opinion.

Other points of circumstantial evidence also demand attention—the position of the bones when discovered in the ground, whether lying at full length or grouped together confusedly. In all bodies which have undergone Christian burial, the skeleton is found lying at full length, with the head to the west and the feet to the east, and one skeleton may be found below another. By an attention to these points, the locality has been at once identified as the site of a burial-ground, where bones have been discovered during excavations for the foundation of new buildings. This inference is confirmed when the bones of persons of all ages and both sexes are found in or near the same spot. In February 1866, a remarkable discovery was made at Milcote, near Stratford-on-Avon. Within two feet from the surface of the soil upwards of two hundred human skeletons were found. They were placed closely side by side upon their backs, with their feet to the east and their heads to the west, and all were well preserved. There were young and old, and skeletons of both sexes, the bones presenting no marks of injury from weapons. This was no doubt the site of an ancient but long-forgotten burial-ground. In pre-historic times, the body was consigned to a stone chest in a sitting posture, with the arms clasped about the knees. Thus, in these ancient graves, the skeleton has been discovered with the thigh bones folded on the chest. It is not unusual to find human mixed with animal bones. I have procured from a deep grave in an old cemetery the bones of a horse mixed with the bones of a male human skeleton. Occasionally, in ancient times, this animal was killed and buried with his deceased owner: and probably the disinterment of these bones in old burial-grounds has given rise to the fables of giants. In one cemetery in the vicinity of London, the bones of the horse were frequently found, when the excavations were carried on to a great depth. The bones of the ox have also been met with in graves mixed with human bones. I have in my possession the upper part of the thigh-bone of an ox, which was dug out of a deep grave in a country churchyard: it was forwarded to me as an unusually developed thigh-bone of a human being!

Identity is sometimes strikingly made out by the presence or absence of the teeth, by their form, position, worn appearance, and the number that may be deficient: and if absent, whether removed recently or long before death. The examination of the teeth often aids considerably in the determination of the age of a skeleton. The discovery of certain articles of clothing, known to have belonged to a missing person, in association with the bones of a skeleton, will sometimes remove any doubts that may arise on the subject of identity. Metal buttons, brooches, or rings, are imperishable, and should be sought for by sifting or washing the earth. In *Reg.* v. *Platts* (Derby Lent Assizes, 1847), prisoner was charged with the murder of a man named Collis. The deceased had not been seen alive since December 7th, 1845. On August 28th, 1846, some men, in cleaning out a cesspool in the neighbourhood, found some human bones with certain articles of dress, which were supposed to be those of the missing man. Besides the ribs, there were two

thigh-bones, and two leg-bones. The flesh readily came off the bones and fell into the soil. With these remains, there was the ordinary dress of a man—namely, coat, hat, trousers, and neckerchief, including two garters, one red and one white. These were still around the bones of the legs. A medical witness, Mr. Walker, stated that he had examined the bones, and found them to be those of a male human being, from twenty-three to thirty years of age. All the bones were complete excepting a few belonging to the neck, and three ribs. On examining the skull, he found a deep fracture in the region of the forehead five inches in extent. There was another fracture over the left eyebrow, and a third across the base of the skull. These fractures, in his opinion, were inflicted on the body while living. The other bones, which appeared to have been separated by the yielding of the ligaments as a result of putrefaction, presented no marks of violence. The injuries to the skull were produced by some cutting or sharp-edged instrument. They were sufficient to cause death, which might have taken place either immediately or after some time. The clothes were identified as those worn by the deceased at the time of his disappearance, and the white and red garters found round the leg bones were identified by a woman who made them, and presented them to the deceased.

The prisoner was connected with the act of murder by a chain of circumstances. On December 7, he was seen with a hammer in his hand quarrelling with the deceased. At a later period, he was seen with two men pushing deceased, who appeared to be in a stupefied state, into his shop. On the night following he was seen in company with two men carrying a heavy substance in a sack, in the direction of the cesspool in which the skeleton was afterwards found. The prisoner had made false statements respecting the transactions between himself and deceased, and the watch and boots of the deceased were traced to his possession. The deceased had been seen with the watch up to within half an hour of his disappearance. The late Mr. Macaulay, for the defence, contended that there was not sufficient proof in law that the remains found were really those of the missing man. The finding of some portions of the clothes of the man in the cesspool was not sufficient to prove the *corpus delicti*—the murder. There must be positive evidence that the remains were those of Collis. Patteson, J., overruled the objection, observing that the identity of the remains was altogether a question for the jury. It was further contended for the defence, that there must not only be clear proof that the remains were those of the deceased, but it must be proved that the deceased had died by the act of the prisoner, and not from any accidental cause. The prisoner was convicted.

But for the discovery of the clothes, more particularly of the two different coloured garters round the leg-bones, the identity in this case could not have been satisfactorily established. The suggestion that the deceased might have fallen into the cesspool by some accident, was negatived by the fact that had this occurred, the watch and boots would have been found with the remains, whereas these articles were clearly traced to the possession of the prisoner. It is worthy of note that in this case the dead human body, in clothes, was reduced nearly to the state of a skeleton within the short period of nine months. This must be ascribed to the influence of the putrescent animal matters by which it was surrounded. That the bones had not been for a longer period in the place where they were found, was proved by the fact that the cesspool had been cleared out only a short time before the disappearance of the deceased.

In July 1863, the bones of a child were found in a nursery-ground at Islington, under suspicious circumstances. It appeared that a girl named *Elizabeth Hunter*, aged eight years, had been missing from the neighbourhood

since March 30th, 1862, and it was important to establish, if possible, that these were the bones of a female child of the age of the deceased. Until the skull was found it was supposed that the bones were those of a dog, but their human character appears to have been ultimately established by the discovery of the skull with some hair, and also of the lower jaw. The medical witness at the inquest assigned the age at from eight to ten years, but could not well define the sex, as at this early period the sexual differences on the pelvis are not well marked. The articles of clothing found with the body served, however, to establish the sex, as well as the identity of the bones with those of the missing child. The remains had the appearance of having been longer in the earth than sixteen months, but it seems they were only superficially covered, and this might account for the rapid destruction of the bones and soft parts. It is probable that the bones of young persons decay more rapidly than those of adults. Cases involving medico-legal questions on the exhumation of skeletons after various periods of interment will be found in the 'Annales d'Hygiène' for 1834, 1, 117; 1836, 1, 214; and 1845, 1, 379. See also Friedreich, 'Ueber die Knochen in forensischer Beziehung.' Ausbach, 1853.

Human and Animal bones.—The greatest ignorance prevails among the public on this subject. The bones of horses, cows, dogs, and sheep are frequently mistaken for those of human beings. In an antiquarian collection of relics obtained from a neighbouring Roman castrum, I saw, some years since, the tibia of a dog carefully labelled and religiously preserved as a bone of an ancient Roman! The same collection contained fragments of bones of various animals, carnivorous and herbivorous, all marked as *human relics*; this collection belonged to an antiquary who had preferred adopting his own view of the nature of the relics, to taking the opinion of any one acquainted with anatomy. In a church in the north of England two bones from oxen were shown to me as the thigh-bones of St. Lawrence. They were of ancient date and greatly prized by the sexton. Even well-informed men may be easily mistaken on such subjects. Belzoni, the celebrated traveller, brought from Egypt, with his sarcophagi, a number of bones taken from the interior of the pyramids, which he pronounced to be the bones of King Cephrenes, and of some of the Shepherd kings. The late Mr. Clift, of the Royal College of Surgeons, informed me that by the request of a friend, he went down to examine them after they had been submitted to public exhibition, and he found that they were nothing more than the bones of oxen! The osseous relics of saints, as they are collected and preserved in glass and crystal cases in Roman Catholic countries, often present anomalies which would surprise an anatomist. Supernumerary ribs and vertebræ are not uncommon, and intermixed with them I have seen bones which certainly never appertained to a human being. In the medico-legal returns for India 1868–9, forwarded to me by Mr. J. C. Brown, it is stated that on one occasion as evidence of an important murder some bones brought from a distance of thirty miles with the usual formalities and precautions as to identity, proved on examination to be those of a bullock, and on another occasion the remains turned out to be those of a goat! I mention these facts because they show the importance of entrusting the examination of bones, in all judicial enquiries, to well-educated medical men. The lower classes of society are ever ready to suspect murder when bones are exhumed; and it will not always be easy to satisfy them that the bones exhumed could not have belonged to a human being.

The lamentable effects of popular ignorance on this subject were displayed in a case that occurred at Damascus in 1840, which at the time excited great public notice. A Roman Catholic priest, with his son, suddenly disappeared in the early part of that year, and a strong suspicion arose that they had

been murdered. Certain Jews were charged with having murdered the father and son for horrible purposes. The sewer in the quarter of the town in which they lived was examined, and some bones were there found. These were pronounced by the persons who discovered them to be human bones; and the discovery was considered to confirm the suspicion of murder which had arisen. Several of the accused Jews died under the tortures to which they were subjected. It seems that the state of anatomy was at that time so low in Syria, that there was no one in the country competent to solve the question whether these were really animal or human bones. Some persons who inspected them, pronounced that they must have been lying in the sewer for a great length of time, and that they had belonged to an animal. A proposition was then made that the bones should be packed in a box, and forwarded to the Parisian Academy of Medicine, for their decision. I believe it was subsequently clearly proved that they were animal remains. Such a case is not likely to occur in England, for there are few professional men who would not be at once able to pronounce an opinion even from the examination of a fragment.

It will be, in most cases, easier to say whether a particular bone has formed part of a human skeleton or not, than to determine to what animal it may have belonged; this is commonly all that is expected from a medical witness. A moderate acquaintance with osteology will enable him to give an affirmative or negative opinion: but where part only of the shaft of a bone—as of the humerus, radius, tibia, or fibula—is produced, some caution is required in forming a judgment. It will not be necessary in this place to describe all the peculiarities of human bones, but rather to point out certain well-marked differences which are observed to exist between the bones of man and animals.

With respect to the *skull*, the foramen magnum in all animals, except the ape-tribe, is placed very far back, and has its posterior edge turned upwards. In the ape-tribe, and especially in the ourang-outang, it is nearer to the centre of the base of the cranium than in any other animal, and is more nearly on a level with the plane of the base of the skull. All animals, including the ourang-outang and ape-tribe, have two bones in the face, in addition to those found in man. These are situated between the superior maxillary bones, and are called ossa intermaxillaria, or, from their holding the incisor teeth, the ossa incisoria. The suture which separates them from the maxillary bones becomes obliterated in some of these animals at an early period; but still traces of it may be plainly seen. To speak of the facial angle as a mark of distinction is quite unnecessary; a medical opinion can never be required except in those cases where only one bone, or the fragment of a bone, is presented for examination. The lower jaw in animals is destitute of a protuberance corresponding to the chin; it is also longer, in proportion to the cranium. The condyles of the jaw vary in shape according to the nature of the food.

The trunk calls for no particular remark. The *vertebræ* are strikingly distinguished by their form, and by the direction of their spinous and transverse processes. Their bodies are longer, and deeply grooved laterally, in a vertical direction. The sacrum is generally narrower in proportion than in man; it is wide in those animals which occasionally stand erect, as in the ape and the bear, but it is also in these animals longer. The pelvis is in all cases much elongated, is narrower, and has less of a basin-like appearance, the level of the brim having a much greater obliquity than in man. The *thorax* of animals without clavicles is commonly compressed at the sides, so as to render it much deeper from the sternum to the spine. This is especially observed in the dog, cat, bear, and in long-legged animals. The ribs,

or fragments of ribs, might perhaps be occasionally confounded. Most mammalia possess more ribs than are found in man, the number corresponding to that of the dorsal vertebræ. The ribs vary much in form, but in herbivorous animals they are generally broad and thick; in the bear and dog they are more rounded. The sternum or chest-bone of the ourang-outang somewhat resembles that of man; it is flat but narrowed, and the division of its pieces is more apparent: in all other animals it differs in being considerably narrower, more or less of a rounded form, and in being evidently composed of many moveable pieces. Most quadrupeds want clavicles: they exist in the ape tribe, and very much resemble those of man, so that the clavicle of the ape might be easily mistaken for that of a young child: in the dog and cat, there is a clavicular bone suspended in the muscles. The scapula or blade-bone of animals, including the ourang-outang and ape, is much longer in proportion, and is more equally divided by the spine, the fossa infra-spinalis being much smaller in proportion than in man. The *os humeri*, or arm-bone, of animals, is observed to become short as the metacarpus is elongated: in the ape tribe, it very closely resembles that of man. In apes the bones of the fore-arm have the same general appearance as in man; but the two bones are long and slender, and the radius is as long as the ulna. In all carnivorous animals, the olecranon is extended farther back, and is more irregular than in man. The carpus, or wrist, in apes, has one bone more than in man. The size and strength of the thumb are much greater in man than in any animal. Even in the ape tribe, although separate and opposed to the other fingers, the thumb is very small and much shorter than in the human species. The *os femoris*, or thigh-bone, in most quadrupeds is so short that it scarcely projects beyond the abdomen: it varies in length according to that of the metatarsus. The neck of the thigh-bone is remarkably short, but the great trochanter rises considerably above the head of the bone even in the ape-tribe. In some animals, as in the horse, the trochanter ends in an unciform process projecting above the head of the bone. In the ourang-outang, the thigh-bone is straighter than in man, while in the bear it closely resembles the human bone. The bones of the leg in the ourang-outang are nearly as in man, but the *tibia*, or leg-bone, is in general considerably longer than the os femoris. In the bear it preserves a proper proportion. In the ape-tribe, these bones are nearly of equal length. In the dog, the fibula is placed behind the tibia, and is attached to it in its lower half. In the horse, the fibula forms merely a kind of splinter anchylosed by age to the upper part of the tibia. In the ruminantia, the fibula is wanting: in the pig it is anchylosed to the tibia throughout its whole length. In apes, while the great toe is shorter than the rest, the smaller toes are much longer than in man. In none of the mammalia, except man, does the foot rest completely on the ground. The os calcis generally wants the tuberosity of the heel; but this exists in the ape-tribe, although to a less extent than in man.

Such are the most prominent differences usually assigned by anatomists to the bones of animals, and based on the observations of skeletons. It is not improbable, however, that in some cases assistance may be derived from the use of the microscope. This instrument may be especially serviceable in those cases of difficulty in which an opinion may be required from only minute fragments of bone. The Haversian canals and bone-cells (lacunæ) exist in all classes of animals which have a bony skeleton; and it has been shown that the bone-cells differ in size in the four great classes of animals. They are smallest in birds, and largest in reptiles: in the mammalia they occupy an intermediate position. In fish, they are entirely different in appearance from those existing in the other three classes. These bone-cells are said to be of the same size in the same class: thus, among mammalia,

they are no larger in the bones of a horse, than they are in those of a mouse. In human bones, the cells are sometimes almost triangular in outline; at other times they have more of a linear or elongated shape. Their number is in an inverse proportion to the Haversian canals in bone. It is desirable that further observations should be made on this subject; and that differences in the microscopical structure of bone should be sought for in the human subject, and in the various orders of mammalia. The late Mr. Quekett ascertained that the cells of bone bore a certain relation, in point of size, to that of the blood-discs of an animal; thus, for instance, the blood-discs were found to be largest in reptiles, smallest in birds and mammalia, while in fishes they were of an intermediate size: and he further discovered that the bone-cells followed the same law. ('Med. Gaz.,' Dec. 11, 1846.) It has happened on several occasions of late years, in cases of infanticide, that great difficulty has been experienced in identifying small portions of bone, when the skeleton has been found partially consumed by fire.

When it has been clearly proved that the bones are not those of a human being, this branch of inquiry is at an end.

Determination of Sex in skeletons.—The determination of the sex from an examination of the skeleton or of certain detached bones, can be made only in subjects which have passed the age of puberty; for sexual differences in the skeletons are scarcely apparent until adult age has been reached. I have, however, seen the well-marked sexual differences of the pelvis in the skeleton of a boy of eleven. The skeleton of the female is smaller and more slender than that of the male. The full-grown bone of a female is distinguished from that of a male by its ridges, depressions, and processes being less marked,—the shaft is smoother and more polished, while the articular surfaces are flatter. The skull of the female is more contracted in front, and forms a longer oval from before backwards. The chest, which is naturally shorter, smaller, and less prominent than in the male, is rather wider about the fourth rib: it then contracts somewhat below, so that while the general shape of the chest approaches to an oval in the female, it is conical in the male skeleton, being wider at the base or lower part. The form of this cavity is often flattened laterally to a considerable extent, owing to the pressure of the stays worn by women. This altered condition of the ribs by pressure may serve to indicate the sex. The sternum or chest-bone, is shorter, terminating opposite the fourth pair of ribs, but its upper portion is larger than in the male; in the latter it terminates opposite the fifth pair of ribs. The ribs are shorter more slender and less arched, and take a more horizontal course in the female; their upper and lower borders are sharper. The false ribs are proportionately larger; and the cartilaginous portions of the true ribs are longer than in the male. The shoulders are lower, and the scapulo-humeral articulations nearer to each other. The clavicles are more slender, more round, and pass in a more straight direction to join the acromion processes. In the male they have somewhat the form of the italic *S*: they are flatter, larger, and run more directly backwards. The female scapula is thinner, smaller, flatter, and has sharper angles than that of the male. The bodies of the vertebræ are smaller, the hole for the spinal marrow and the foramina are larger; and the lumbar vertebræ have greater length than in the male.

The upper limbs are shorter, the carpus smaller, and the metacarpus and phalanges are more slender in the female than in the male. The thigh-bones have a greater curvature forwards at the upper part, and are turned more obliquely inwards, below. The neck of the thigh-bone in the female forms nearly a right angle with the shaft, whereby the trochanter major is brought more nearly on a level with the head of the bone. In the male the

neck of the femur is inclined obliquely upwards, and the trochanter major is below the level of the head. In the female the internal condyles are larger. The bones of the leg are more slender and those of the feet are smaller than in the male.

The most remarkable difference is observed in the *pelvis*, and it is by an examination of this portion of the adult skeleton, when it can be obtained, that the sex may be most satisfactorily made out. In the female the ossa ilii are flatter and more everted, giving to the whole pelvis a greater capacity; the os sacrum is broader, and turned more backwards; the os coccygis more slender, moveable, and turned more backwards, the space between the ossa pubis larger, and the cartilage of the symphysis broader. The angle formed by the rami of the ossa pubis with the symphysis is larger. In a well-formed male skeleton I have found the angle to be 73°, while in a well-formed female skeleton the angle was equal to 90°. The tuberosities of the ossa ischii are flatter and at a greater distance from each other. The brim of the pelvis is wider and of an oval form, corresponding with the head of a child, and the longest diameter extending between the ilia or transversely. In the male the brim is more circular, and the greatest diameter is between the pelvis and sacrum. The foramina ovalia in the female are wider, and approach more to a triangular form than in the male, one sharp angle being at the junction of the pubis with the ischium; the acetabula are farther distant from each other. The pelvis of the female loses some of its well-marked sexual characters in advanced life.

It will be understood that these differences are for the most part relative, and some are so slight that they can scarcely be regarded as characteristic of the sexes. Great difficulty in forming an opinion will exist in those cases where only a fragment of a bone can be procured; but a medical witness is not expected to work out impossibilities: if he has a sufficient portion of a skeleton before him, he may be able to determine the sex, otherwise it would be advisable to state that the remains produced did not enable him to answer the question, and that the bone or a fragment might have belonged either to a male or a female. In a contested case of presumption of survivorship which occurred some years since, it became necessary to determine the relative weights of the adult male and female skeletons. A perfect male skeleton from Guy's Museum, was found to weigh ten pounds six ounces: and a perfect female skeleton eight pounds, thirteen ounces. The bones were completely dry. It may be observed that bone is the heaviest part of the human body; its specific gravity is 2·01.

Date of interment.—One of the first questions asked on the disinterment of bones, relates to the length of time during which they may have remained buried in the ground. The period at which the bones begin to undergo decomposition, will depend upon that at which the soft parts have entirely disappeared. The common opinion is, that the soft parts are destroyed in ordinary graves in about ten years. Bernt, however, mentions a case seen by Navier, in which some fleshy parts of the body remained after an interment of twenty-one years. The changes in the bones are observed to commence by the loss of animal matter, so that they become lighter; externally they acquire a dark incrustation when in contact with the earth. This dark incrustation is sometimes confined to the surface; but in some very ancient bones in my possession, the osseous shell is of a dark-brown colour throughout, like old oak. The animal matter is never entirely lost; it exists in bones which have been buried for many centuries, and may be made evident by digesting them in hydrochloric acid. Even in sawing them, the heat of friction brings out a peculiar animal odour. The shaft of a long bone, becomes, after long burial in a dry soil, light and very brittle; it may be

easily broken, and cut or scraped with a knife. It appears to me to be impossible to assign, with any approach to precision, the period required for the production of these changes; they vary with the age of the subject, taking place more rapidly in the skeletons of the young: they vary also with the nature of the soil in which the bones are buried, according to whether this is dry or humid, sandy, cretaceous, or argillaceous. Some have alleged that the bones of a person buried in an ordinary coffin are entirely destroyed, with the exception of the skull and thigh-bones, within a period of thirty years; but I have seen a perfect skeleton of the body of a male that had been buried in a dry soil for thirty-four years; and there are many cases on record, where the skull and long bones have been found, in ordinary graves, quite perfect after a much longer period than thirty years. In general, the lower jaw of adults is preserved for a great length of time, and with it the teeth, which from the hardness of the enamel resist decomposition longer than any other parts of the body. The ultimate destruction of the bone is effected by the complete disintegration of its earthy parts, the phosphate and carbonate of lime falling into and mixing with the earth around. Bones owe their preservation to the large proportion of mineral matter contained in them. This is greater in the adult than in the child. Von Bibra found the following proportions of mineral matter per cent. in recent bones of different ages:—In a woman (æt. 62), 69·82: in a man (æt. 25), 68·97: in a child (æt. 5), 67·80: in a child of two months, 65·32: in a fœtus of seven months, 65·19: and in a fœtus of six months, 59·62. The proportions in the bones of animals, are similar to those of the human adult.

On the discovery of one or more bones, or of a skeleton, the question may be: Can it have been buried for a longer period than fifteen or twenty years? Suspicion may arise that they were the bones of a person alleged to have been murdered, and who had disappeared about that period. In some cases this question may admit of a ready answer. If it were the long bone of an adult, and it was found to be light, friable, brittle, and easily scraped to powder, it is probable that it had been interred for a much longer period than that above mentioned. We can form only a rough opinion of the period of interment of bones, by the presence or absence of the soft parts; of marrow in the interior; by the firmness and weight, or brittleness, dryness, and lightness of the bone. Even these remarks can scarcely be made applicable to bones preserved in durable coffins or vaults; for in this state they are to a great extent removed from all the common causes of chemical change. Devergie states that the bones of King Dagobert were found in a tolerably perfect state at St. Denis, although they had been buried in a vault twelve hundred years. In the year 1868 the skeleton of William Rufus was found in a stone coffin at Winchester, nearly perfect, after 780 years' burial. The skull was in fragments, the vertebræ were almost complete; parts of the pelvis and sacrum (showing the male characters), the bones of the arms, the femoral bones and two tibias were found. The lower jaw with nine teeth, the enamel apparently unchanged, was also discovered. There were no clavicles and only six ribs, and the small bones of the hands and feet had disappeared.

In bones long buried, a portion of the animal matter is lost, the bone becomes light and brittle, and is easily reduced to powder. In May 1868, Mr. Elliston of the East Suffolk Hospital sent to me for examination a portion of the scapula and rib of a skeleton which was found eighteen inches below the surface in the sandy soil on the top of a hill. The skeleton, which was that of a female, was perfect, excepting the lower ends of the tibiæ and feet, which were decomposed. It had the appearance of having been thrust violently into the ground. There were no traces of soft parts. The teeth in the upper

jaw, including the *dentes sapientiæ* were perfect and regular, and the age was considered to be from twenty-three to twenty-eight years. No hair and no articles of clothing were discovered. On analysis the bones were found to contain 72 per cent. of mineral matter, and the presence of fluorine was detected in a small quantity of bone reduced to powder. The date of interment was assigned at from fifty to one hundred years.

A question which has yet to be determined is whether, as with the fossil remains of animals, human bones after long interment may not contain a larger proportion of fluoride of calcium than when recent. It has been ascertained that the ancient bones of extinct animals contain a large proportion of fluoride, while in recent bones the proportion is so small that it requires a large quantity of bone to determine its presence. It need hardly be observed, that these medico-legal questions are likely to arise only in those cases in which the bones have been found under suspicious circumstances in an unusual locality, as in the cellar or basement of a house, or in a garden: and it will always be proper to make further exploration to see whether the bones of different persons may not be found lying near.

Determination of Age in skeletons.—In regard to the remains of the young, the age may be best determined by an examination of the jaws and teeth, although the skeletons of the young are at once characterized by the smallness of the bones. If the jaw of a child can be found, medical evidence may be given of its probable age. In a case of alleged infanticide, which occurred in France, there were found among the exhumed bones of two children, parts of the jaws, containing the rudiments of the molar teeth, which appear about the eighth or ninth month of pregnancy. This fact showed, what was rather important to the inquiry, that the child to whom the jaw belonged must have been born at or about the full period. It may be alleged that the bones are those of a child which has been murdered; but the medical witness may be able to prove, by an examination of the jaws, that the bones must have belonged to a child older or younger than that which is missing. There are numerous other cases in which a question of this kind may become important. The determination of age by an examination of the bones of young persons, is by no means so satisfactory as by the observation of the *teeth.*

The alveolar cavities which contain the teeth are said to be formed about the sixth month of uterine life. At birth the rudiments of the whole of the temporary teeth, and of the anterior permanent molars, are formed in capsules within the gums; and about this period, the fangs of the incisors begin to appear. Great difference of opinion exists respecting the time at which the *temporary teeth* begin to rise above the gums in a child after birth. According to Mr. Bell, these teeth appear in the following order:—The four central incisors in from *five to eight months*; the four lateral incisors in from *seven to ten months*; the four anterior molars in from *twelve to sixteen months*; the four cuspidati in from *fourteen to twenty months*; and the four posterior molars in from *eighteen months to three years.* The temporary are known from the corresponding permanent teeth by their much smaller size, by the absence of bicuspides, by the fact that the fangs diverge at a greater angle from the molars; and there is another and remarkable point of difference, according to Mr. Saunders, namely, that the enamel at the neck is collected into a kind of ridge, instead of terminating, as in the permanent set, evenly on the fang. This is especially apparent in the incisors and cuspidati, but, as Mr. Saunders has remarked, it applies to all the temporary teeth. Between six and seven years of age, the jaws contain forty-eight teeth—twenty of the temporary set in a perfect state, and twenty-eight of the permanent set more or less developed and placed behind the temporary teeth which they are to

replace. According to Mr. Saunders, the order in which the permanent teeth appear is as follows:—At *seven* years of age, the four anterior molars; at *eight* years, the four central incisors: at *nine* years, the four lateral incisors; at *ten*, the four anterior bicuspides; at *eleven*, the four posterior bicuspides; at from *twelve* to *twelve and a half* years, the four cuspidati; and at from *twelve and a half to fourteen* years, the four posterior molars: thus making the total number of teeth in the jaw at this period twenty-eight. The dentes sapientiæ seldom make their appearance before the age of eighteen, and often not until a much later period in life. In general, the teeth of the lower jaw make their appearance before those of the upper. Some irregularities may occur in the periods at which the teeth appear; but according to nnmerous observations made by Mr. Saunders and others, the description just given is applicable to a large majority of cases, and is sufficiently correct for practical purposes.

In addition to the examination of the teeth, medical jurists are accustomed to rely upon the progress of ossification in the skeleton, as furnishing evidence of age at the early periods of life. At *one year*, ossification commences in the lower extremities of the humerus and ulna, in the heads of the femur and humerus, and in the upper cartilage of the tibia. At *two years*, ossification takes place in the lower cartilage of the radius, and in the tibia and fibula. At *two years and a half*, it takes place in the greater tuberosity of the head of the humerus, in the patella, and in the lower ends of the four last metacarpal bones; at *three years*, in the trochanters; at *four years*, in the second and third cuneiform bones of the tarsus; at *four and a half years*, in the small tuberosity of the head of the humerus. and the upper cartilage of the fibula; at *six years*, the descending ramus of the pubis meets the ascending ramus of the ischium. At from *eight to nine years*, the upper cartilage of the radius becomes ossified. At *nine years*, the ilium, ischium, and pubis, meet in the cotyloid cavity to form the pelvis. At *ten years*, ossification begins in the cartilaginous end of the olecranon; at *twelve*, in the os pisiforme of the carpus; at *thirteen*, the three portions of the ossa innominata still admit of separation into ilium, ischium, and pubis, although nearly united; the neck of the femur is ossified. At *fifteen*, the coracoid process is united to the scapula; and *between fifteen and sixteen*, the olecranon to the ulna. From *eighteen to twenty*, the epiphysis at the upper end of the thigh-bone is joined to the body of the bone; as well as those belonging to the metacarpus, metatarsus, and phalanges. At *twenty*, the upper and lower epiphyses of the fibula, as well as the lower epiphysis of the femur, are respectively united to the bones. At *twenty-five years*, the epiphyses of the sternal end of the clavicle, and of the crista ilii, are united to the bones. This account of the progress of ossification may be taken as a representation of average results. In the cavity of the skull of young persons, the furrows produced by the convolutions of the brain and by the vessels, are commonly very strongly marked on the bones.

When ossification is once completed, it is difficult to determine the age by an examination of the bones. That the person has reached *adult age*, will be indicated by the union of all the epiphyses to the bones, by the great firmness and solidity of the bones, with their rough surfaces for the motion of muscles, their well-marked processes, grooves, and foramina. In the jaws, we may expect to find the dentes sapientiæ; while the other teeth will probably be found much worn, although this last sign is not of any great importance. The lower jaw forms a great angle, being somewhat of an elliptical form, and is strongly contrasted with the semicircular shape of the jaw at an early period of life; the sutures are also closed, and are found in some instances nearly obliterated.

The bones of an old person are generally lighter than those of an adult of the same size, the medullary cavities of the long bones being larger. The bones lose that ivory-looking character which they have in adults, become yellow from the quantity of oil which they contain, more earthy, and brittle. Those parts of the skeleton which are cartilaginous in adults, are commonly more or less ossified in old age. The bones of the cranium are thinner; the sutures entirely disappear, first on the inside, and then on the outside of the skull. The teeth have either dropped out, or the crowns are worn away to the sockets. Sometimes no trace of alveolar cavities is to be seen, the lower jaw being a mere rounded bone, with a smooth surface on each side. A remarkable case occurred at Norwich in 1869, which shows the necessity of using extreme caution in giving an opinion respecting the age of bones, and of always allowing sufficient latitude in years for the bones of adults. In June 1851, numerous portions of a mutilated human body, consisting of flesh and bones, were found around the suburbs of Norwich. The portions of bone found belonged to one body, and the pelvis and thigh-bone as well as a portion of the breast and skin, showed that it was the body of a woman of adult age. The opinion then given from the bones was that the deceased was a 'young adult female' between sixteen and twenty-six years of age. About eighteen years after this discovery, a man of the name of *Sheward* confessed that he had murdered his wife at Norwich in June 1851, that he had cut the body to pieces and disposed of the mutilated portions in the suburbs. It appeared further that his wife had really disappeared about that time, and had never been seen since; but she was a woman in her fifty-fourth year; and without some strong corroboration the man's confession could not be received against himself. The facts all concurred to show that the remains found in 1851 must have been those of the missing wife, the only circumstance opposed to this view being the medical opinion given at the time that the bones were those of a woman considerably younger than the deceased. The man was tried for the murder at the Norwich Lent Assizes 1869 (*Reg.* v. *Sheward*), and the medical witnesses who had given their opinion respecting age were cross-examined on this point. They admitted that the remains might have been those of the deceased woman. Indeed every fact in the case pointed to this, and the confession of the prisoner (subsequently withdrawn) was so far confirmed, that the prisoner was convicted. There could be no doubt that a mistake had been made in limiting the age to twenty-six. The correctness of the verdict was proved by the confession of the prisoner after conviction. The mutilation had been carried to that extent that even the ring-finger had been cut off, and portions of flesh had been found which had apparently been immersed in hot water. The prisoner stated in his confession that he had endeavoured to get rid of some portions of the remains by boiling them. The same condition was observed in the Waterloo Bridge case (p. 133). The state of the remains indicated death within a week or ten days of their discovery; this was also confirmed by the prisoner's confession. The prisoner, after committing the murder occupied about a week in disposing of the mutilated remains. He cut the long hair into short portions, and scattered it to the winds as he walked along the roads.

Identity from the teeth.—Observations carefully made on the state of the jaws and teeth may have an important bearing in cases of disputed identity. The loss of particular teeth, the presence of supernumerary teeth, or the entire absence of teeth for a long period, may, if noticed by the medical inspector, lead to the removal of many difficulties in the identification of skeletons. An instance of this kind occurred to me some years ago in a case which Mr. H. Reynolds and myself were called upon to investigate. It was a trial

for murder under circumstances in which the body was never discovered, and in which, as it happened, an important question of identity arose, founded on the presence of the incisor teeth in a female of advanced age. The case to which I allude is that of *Elizabeth Ross*, who was tried at the Old Bailey Sessions in December 1831, for the murder of a female of the name of Caroline Walsh.

It appeared in evidence, that the deceased, Caroline Walsh, who was an old Irishwoman, had been repeatedly solicited by the prisoner to come and live with her and her husband, but the deceased refused. By much persuasion on the part of the prisoner, however, she at last consented, and went for that purpose to the prisoner's lodgings in Goodman's Fields on the evening of August 19, 1831, taking with her, her bed and an old basket, in which she was accustomed to sell tape and other articles. From that evening all traces of the deceased were lost; and when the prisoner was required by her relatives to account for her disappearance, she prevaricated, but finally asserted that deceased had gone out early on the morning of that day, and had not returned. The testimony of the prisoner's son, who was the chief witness for the Crown, went to prove most clearly, that the deceased had been wilfully suffocated on the evening of her arrival, by his mother (the prisoner) placing her hands over the mouth of the deceased and pressing on her chest. He deposed that on the following morning he saw the dead body of the old woman lying in the cellar of the house, and on the evening of the same day, he saw his mother leave the house with something large and heavy in a sack. This was at the time when murders were perpetrated in London to supply the Anatomical Schools with subjects for dissection.

Now it happened most singularly that on the evening of August 20, the day following the alleged murder, an old woman of the description of the supposed deceased, was found lying in the street in the immediate neighbourhood, in a completely exhausted condition, and in a most filthy and squalid state. On being questioned she stated that her name was Caroline Welsh, and that she was a native of Ireland. Her hip was found to be fractured, in consequence of which she was conveyed to the London Hospital, where she subsequently died and was buried. The prisoner Ross, when apprehended, asserted that this was the female whom she was accused of having murdered. Hence, setting aside the direct contradiction given to this statement by the evidence of her son, it became highly important, for the ends of justice, that the identity or non-identity of the two women should be clearly established.

The extraordinary resemblance of names, and the exact coincidence of time and place, struck every one in Court; but by the examination of about twenty witnesses, the following points of difference were elicited. It was proved that they were both Irishwomen, but Caroline Walsh came from Kilkenny; Caroline Welsh, from Waterford. The former (the alleged murdered person) was eighty-four years of age; tall; of a sallow complexion; grey hair, and had (an extraordinary circumstance for her years) very perfect incisor teeth. The latter, Caroline Welsh (who died in the London Hospital) was about sixty years of age; tall of stature; dark like a mulatto, but had no front teeth, in addition to which it was deposed by a medical witness that the alveolar cavities corresponding to them *had been obliterated for a considerable time.* The witness brought the skull and jaw into Court—for the body had been purposely exhumed for this examination—but the judge (the late Lord Denman, then Recorder of London) would not allow it to be produced, and said he would be satisfied with the witness's statement respecting the condition of the jaws.

Other circumstantial points of difference were deposed to—as, for example,

Caroline Walsh was healthy, cleanly, and neat in her person, and her feet were perfectly sound. Caroline Welsh was considerably emaciated; she was in a dirty and filthy condition; her hip was broken, her feet were covered with bunions and excrescences, and one toe overlapped another. The dress of the two women was somewhat similar. That of Caroline Walsh was most clearly proved to have been sold by the prisoner Ross to different persons; and almost every article was reproduced in Court, and sworn to by witnesses. The clothes of Caroline Welsh were proved to have been burnt by order of the parish authorities. Both of these women had similar baskets in their possession; that of Caroline Walsh had no lid or cover, while that found on Caroline Welsh had a cover. Lastly, the body of the latter was taken up from the burial-ground of the London Hospital for the purpose of identification, and it was sworn by two of the grand-daughters of Caroline Walsh not to be the body of their grandmother.

This is perhaps one of the most singular cases of disputed identity that has come before a British Court of Law. We have a coincidence of name, time, place, age, occupation, and circumstances, so extraordinary, that but for two circumstances it is probable the prisoner would have escaped on the presumption of a mistake, the body of the deceased not having been found although all the dissecting-rooms in London were repeatedly searched for it. These circumstances were—1st. That the relatives of the deceased swore that the exhumed body was not that of the missing woman; and 2nd, the medical proof of the entire obliteration of the alveolar cavities in the jaw of the exhumed body, proving that the incisor teeth must have been lost long before death, while several witnesses testified to the presence of these teeth, as a striking peculiarity in the missing old woman. Even had the features of the exhumed body been obliterated by putrefaction, the non-identity would have been established by this medical fact. The prisoner was convicted and executed.

In February 1864, a man named *Weekly Ball* was charged with the murder of a woman named Lydia Atlee, with whom he had cohabited. It appears that, while in the last stage of pregnancy, she had suddenly disappeared on July 22, 1850, and was never seen again. It was rumoured that she had been murdered, and the prisoner, who, it was alleged, had a strong motive for getting rid of her, was suspected of the act; but no legal proof could be obtained against him, and the matter dropped. On February 3, 1864, as a labourer was digging in a lane, by the side of a ditch near the village of Ringstead, in Northamptonshire, where deceased and the accused had lived, he found a human skull and ultimately a skeleton, lying at full length with its face downwards. The medical evidence at the magisterial inquiry was to the following effect: The skeleton was lying in a trench about twenty inches below the surface of the ground in a swampy soil. The feet were close together, the heels touching each other. From these facts Mr. Leete, the surgeon, expressed an opinion that the body must have been buried naked. The skeleton, when laid out, was that of a middle-aged female, about five feet two inches in height. The bones were complete, excepting the right thigh-bone and skull, which were broken in their removal. He considered that the skeleton had been in the earth from twelve to twenty years. The woman was far advanced in pregnancy, but no *fœtal bones* were found. In reference to this, the surgeon stated that the bones of a fœtus contained more animal matter, and might have been decomposed, although he declined to swear that within the period of fourteen years they would have entirely disappeared. No hair was found, although sought for, and no traces of clothes of any kind could be discovered; but there was a singular fact connected with the lower jaw, by which it was supposed the skeleton could be identified as that of

the missing Lydia Atlee. A witness stated that a *fortnight* before the woman was missing, he drew a double tooth from the lower jaw (the first molar on the left side). When the exhumed jaw was shown to him, this tooth was absent, and he affirmed that that was the place where he drew the tooth. He thus appeared clearly to identify the skeleton as that of the missing woman. The evidence of other witnesses was adduced to show that on the evening of July 22, 1850, the accused and Lydia Atlee were seen to go together into an orchard at the back of the accused's house. They were overheard quarrelling, and the woman's voice was identified, muttering the words, 'I believe you mean killing me to-night.' It appeared that the skeleton was found buried about a mile from this orchard. Dr. Markham, who gave evidence in the case, said in reference to the pregnancy of the woman, if it was a nine months' fœtus, some of the fœtal bones ought to have been found with the skeleton; the hair might have disappeared in thirteen years. With regard to the lower jaw, he observed that if the tooth was extracted, it could not have been removed long before death. The cavity was partly filled up, a fact which might however be explained by the tooth having been extracted without one or all of its fangs.

Although the identity of the skeleton, as that of the missing woman, was thus left a little uncertain, the accused was committed for murder. In the meantime the ground was again searched for fœtal bones, and the result was that, about eighteen inches deeper in the earth, the skeleton of a full-grown man was found, foot to foot with that of the female skeleton above. That of the man was lying on its back, and the bones appeared to have been much longer in the ground. On this discovery, it was suggested that the spot might have been a gipsy's burial-place, in which one body was laid in a grave over another without the ordinary clothing. That the accused should select a spot a mile away from his dwelling for burying the body of a woman whom he had recently murdered, and that he should then place the body at full length, over another dead body just below it, was most improbable. The entire absence of the fœtal bones was another fact adverse to the alleged identity. I am assured by an eminent dentist who examined the lower jaw, that the tooth, supposed to have been drawn a fortnight before death, is one of the most common teeth to be absent in the jaws of middle-aged persons, and further, that it might have been removed from the jaw for three or more months before death. There was nothing by which a more recent date could be fixed, as part of the cavity had been filled up by the usual osseous structure. At the Northampton Lent assizes, 1864, the accused was discharged on bail.

Questions of identity may turn, not only on the number and nature of the natural teeth, but also on the presence of artificial teeth, with the mechanical appliances for securing them. On the trial of *Professor Webster* for the murder of Dr. Parkman, the evidence given by a dentist, Dr. Keep, established the identity of the mutilated remains of the deceased, in spite of an attempt which had been made to destroy the jaws by fire (p. 132). This gentleman deposed that about four years previously, he had made and fitted for Dr. Parkman sets of artificial teeth in blocks for each jaw. He saw Dr. Parkman with these teeth in his head, for the last time, about a fortnight before his disappearance. He then put a new spring to the teeth. He recognized the artificial teeth, taken from a furnace, by certain peculiarities about them, and also by their fitting the original plates and moulds, which he retained in his possession. The gold plates attached to them had been melted in an assay furnace, in an attempt to destroy the head of the deceased, but the greater part of this gold was recovered, and the artificial teeth, to which the gold plates had been fastened, had acquired a pink colour from a portion of the

finely divided metallic gold, showing that they had been submitted to a high temperature, but had not undergone fusion, although minute particles of gold were fused into them. The left side of the lower jaw presented a great natural irregularity. The block corresponded to this, and thus placed the identity of the jaws beyond dispute. ('Report of Trial of Prof. Webster,' Boston, 1850, p. 50.) Dental peculiarities frequently serve to assist identification. In the 'Medico-legal Returns for India' (1868–9), it is stated that a wife was able to swear to the identity of her husband's skull, shown to her in open Court, from a peculiarity of the incisor teeth of the upper jaw, brought to notice by the civil surgeon. It seems that these cases of identity from bones are very common in India. The records of 1869 contain nineteen reports upon bones and fragments. The character of the fragments were very various —a skull and a few bones picked out of a river, pond or well, or gathered out of a jungle. In one of these cases an imperfect skeleton, alleged to belong to a man murdered eighteen days before, was brought for examination, and found to be the remains of a woman! In Dumoh the skeleton of a male body, the soft parts of which had been eaten, was brought for examination on the 16th April, and the civil surgeon was enabled to state that these were not the remains of a man who died on the 14th. In Lahore, in 1868, a case occurred in which a careful examination of bones was required to be made in reference to a charge of murder. Age and sex were determined, and incised wounds of the skull and lower jaw were detected and described. On this discovery the husband absconded. ('Gen. Report for India,' 1870, p. 95.)

Bones and teeth which have been long buried may, by percolation of water through the soil, become impregnated with oxide of iron, sulphate of lime, or the carbonates of magnesia and lime. They are heavy, of a dark brown colour, and generally contain much lime and iron, with fluoride of calcium. In some bones, disinterred near one of the plaster quarries of Paris, Lassaigne found, besides 66·7 of the usual mineral constituents, 2·3 per cent. of sulphate of lime, with traces of oxide of iron. Other bones, of soldiers killed in 1814, and buried near the same spot, yielded 56·1 of sub-phosphate and carbonate of lime, 0·5 of sulphate, and 8·2 per cent. of argillaceous sand. These bones had been buried for a period of thirty-three years. They contained 15 per cent. of animal matter and 20 of water. Those taken from the plaster quarry contained the same quantity of water, but only 11 per cent. of organic matter. ('Annuaire de Chimie,' 1847, p. 759.)

Determination of stature.—The average stature of Englishmen is from five feet six to five feet nine inches, or, according to Dr. Beddoe, five feet seven inches; about four out of one hundred are calculated to have a stature of from six feet to six feet three inches. In determining the stature from the measurement of the entire skeleton, it is usual to add from an inch to an inch and a half for the thickness of the soft parts. When the bones are entirely disarticulated, they should be laid out in their natural order, and an estimate made. Medical jurists have endeavoured to determine the stature of a skeleton from the measurement of one or more of the long bones—as, for example, of the femur, tibia, fibula, humerus, radius, and ulna; but the rules for this mode of calculation are unsatisfactory: and as M. Devergie has clearly shown from the tables, they are liable to lead to an error of five inches at the least. The fact is, there does not appear to be any uniform relation between the length of these individual bones and the stature of a person. In tall persons it is observed that the bones of the lower limbs are proportionably longer than those of the upper; but we are liable to meet with all kinds of anomalies, and the best that can be said of this mode of measurement is, that it can never be proved wrong: for in general there can be no witness to speak to the stature of the person while living, in cases in which a medical inves-

tigation of this kind is directed to be made. We advance very little to a solution of this question, even by deducing the average length of a long bone from the measurement of a large number of similar bones. The differences in the length of the bones will be great according to whether the measurement is made from the edge of one articular surface to the other, or whether the processes are included or excluded, such as the styloid process of the ulna and the inner malleolus of the tibia.

I have below drawn up the measurements of three adult male skeletons, which were taken as accurately as possible by the repeated examination of the numerous skeletons in the museum of Guy's Hospital. Nos. 1 and 2 comprise nearly the average stature of Englishmen; No. 3 represents the skeleton of a tall man. The height here is the bare measurement of the bones with the soles of the feet resting on the ground: an addition of at least an inch should be made for the soft parts. The lengths of the tibia and fibula were taken between the articular surfaces. From end to end the fibula is a remarkably long bone. I have found it in adults to be in many cases as long as fifteen inches.

Adult Male Skeletons.

	No. 1. Ft.	No. 1. In.	No. 2. Ft.	No. 2. In.	No. 3. Ft.	No. 3. In.
Stature (sole on the ground) .	5	6	5	9	6	0
Transverse measurement from extremity of middle fingers	5	6½	5	10½	6	1
Femur . .		17⅜		18		19½
Tibia between art. surf.		15⅜		14¾		15½
Fibula between art. surf.		13½		14		14½
Humerus . .		12		12		13¼
Radius . .		9		9¼		9⅜
Ulna . . .		10		10⅜		10⅜
Clavicle . .		5⅝		6		6
Hand from carpus, joining the radius . .		7		7¼		6½

The subjoined table contains the measurement of two female skeletons; the one of an adult, the other of an aged woman.

Female Skeletons.

	Adult Female. Ft.	Adult Female. In.	Aged Female. Ft.	Aged Female. In.
Stature . .	5	2½	5	
Transverse length	5	2½	5	¾
Femur . .		16		16
Tibia . . .		12¾		12½
Fibula . .		12½		12¼
Humerus . .		11⅛		11¼
Radius . .		8		7⅛
Ulna . . .		9		8¾
Clavicle . .		5½		5
Hand from the wrist . .		6½		6¼

These are the measurements of the bones of the arm of a well-formed soldier.

Arm of a Soldier.

	Inches.
Humerus	12½
Radius	9¼
Ulna	10¼
Clavicle	6
Hand from wrist . . .	7⅜
Total length of arm . . .	29½

$29\frac{1}{2} \times 2 = 59$

Clavicles 12

Sternum $1\frac{1}{2}$

Stature about 6 feet.

The following are full-length measurements of perfect but detached bones of a male skeleton used for anatomical demonstration :—

Detached Bones of a Male Skeleton.

	Inches.
Femur	18
Tibia	15¼
Fibula	15
Humerus	12¾
Ulna	10¼
Radius	9¼

In the course of these investigations an attempt was made to determine whether there was any correspondence between the transverse length of the skeleton, measured from the extreme ends of the phalanges of the middle fingers, the arms being maintained in a horizontal position. It will be seen that both in the male and female there is a very near approximation in these measurements. We have only the bones of the arm of a male adult; we may, by doubling its length, and adding twelve inches for the two clavicles, and an inch and a half for the sternum, determine approximatively the stature. Thus, by applying this rule to the arm of the soldier, of which the measurements have been just given, we should have a stature of six feet. This method of taking a whole extremity, although only approximate, is likely to lead to less error than that of determining the stature by the measurement of a solitary bone. In the disinterment of the remains of William Rufus (see page 146), an attempt was made to determine the stature of the king. The tibias were $16\frac{1}{4}$ inches long, the thigh-bones were 19 inches, and the spine was 26 inches in length. Comparing these measurements with those above given, the inference is, that Rufus was a tall man, nearly if not quite six feet in height.

Below are two measurements, the one of a male skeleton between *ten and eleven years of age*, the other of a mature child at the end of *nine months'* utero-gestation. The dried cartilages at the ends of the long bones are not included in the measurement of the latter, because they are never found in graves; we have merely the osseous portions to examine.

	Male Skeleton naturally articulated. Ft. In.	Mature Child at 9 months. In.		Male Skeleton naturally articulated. Ft. In.	Mature Child at 9 months. In.
Stature	3 10	$19\frac{3}{4}$	Ulna	$6\frac{3}{4}$	$2\frac{1}{4}$
Femur	$11\frac{3}{4}$	3	Clavicle	4	$1\frac{3}{8}$
Tibia	$9\frac{3}{4}$	$2\frac{5}{8}$	Hand from wrist	5	2
Fibula	$9\frac{1}{2}$	$2\frac{1}{2}$	Arms, each		$8\frac{1}{2}$
Humerus	$8\frac{1}{2}$	$2\frac{1}{4}$	Measurement across the chest		$3\frac{1}{4}$
Radius	6	2			

Béclard remarks on the stature of the body, as determined by the dimensions of the skeleton, that it is about five feet four inches for an adult male, and about five feet for an adult female; but it is subject to great variation, not merely in the various races of men, but in individuals of the same race and nation. The extremes, however, are comprised within certain limits. Thus dwarfs (as adults) are rarely less than one-half of the average stature, while giants are seldom more than one-half above the average.

Determination of age from stature.—In attempting to determine the age of a skeleton from the measurement of the bones, it must be remembered that there is a great difference in the rapidity of growth, not merely in children of the same sex, but in children of different sexes. Sometimes a child will be much under the average stature before puberty, but will rapidly grow after having passed this period: hence the subjoined table, taken from M. Sue, is scarcely available for practical purposes. We must, at any rate, allow of the possible existance of great deviations. Here is the table, somewhat modified by additional observations.

Age.	Stature. Ft. Ft. In.	Age.	Stature. Ft. Ft. In.
At one year	2 to 2 3	At fourteen to sixteen	4 to 5
„ three years	3	„ twenty to twenty-five	5 to 5 6
„ ten to twelve	4		

The full stature, however, according to some recent observations, is rarely attained until the age of from twenty-five to twenty-seven years. This table

refers to the stature of living persons; it will be somewhat less for the skeleton.

M. de S. Luca brought before the Academy of Sciences the results of his researches on the relative length and weight of the bones which constitute the human skeleton. ('Cosmos,' Oct. 2, 1863, p. 386.) He demonstrated the existence of relative proportions among parts of the body which had not previously been suspected. His view is, that in the construction of animals there is among the various organs a uniform relation of weight, length, and surface. The average stature of an adult man is, according to him, five feet three inches (1 mètre, 60 centimètres), that of an adult woman one-twentieth less, *i.e.* within a small fraction of five feet. The head forms one-eighth part of the total height of the body: this is divided into two equal parts immediately below the eyes, while the nostrils are midway between the eyes and chin. In a vertical section of the body, the pubis is a central point between the two extremes. When the arms are raised vertically above the head, the umbilicus or navel, which is one mètre (39·37 inches) from the sole of the foot, then becomes the centre of the length. It may be further remarked that the height of a man corresponds to the distance which separates the extremities of the two hands, when the arms are extended in a horizontal line from the body. The arm may be divided into five parts, the hand representing one part, while two others are occupied by the forearm, and the remaining two parts by the upper arm, the elbow being the boundary of these divisions. Whatever the length of the hand, five times that length will represent the total length of the arm, so that if the hand is 133 millimètres (5·22 inches) the arm will be 666 millimètres (26·13 inches) in length. In reference to the hand, the carpal and metacarpal bones represent one half of its length. The first phalanx of the middle finger is equal to one-fourth of the hand, and the two last phalanges of this finger, taken together, are exactly equal to the length of the first phalanx. The last phalanx is itself naturally divided by the nail into two equal parts. The sole of the foot is a third longer than the palm of the hand, but the back of the foot or instep is of the same length. The observations made on the weight of the bones showed: 1, that the bones of the right side of the body were heavier than those of the left. 2. The weight of the bones above the navel is equal to the weight of those which are below that point. 3. The weight of the bones of the hand is equal to the fifth part of the weight of the bones of the arm. There is the same relation here as in length. 4. The total weight of the hand may be divided into five equal parts, one represented by the carpal, two by the metacarpal bones, and two by the bones of the fingers. The first phalanx is equal to two-thirds of the weight of the entire finger, the other third being represented by the two remaining phalanges. 5. The bones of the hand are equal to half the weight of the bones of the foot. 6. In the foot there are similar relations. The weight of the tarsal is double that of the metatarsal bones, and the weight of the toes is divided into three parts, two for the first phalanges and one for the two small phalanges.

Difference of Race.—There are certain differences in the skeleton, according to whether it belongs to an individual of the Caucasian, Mongolian, or Negro variety of mankind. The differences chiefly relate to the proportion which the skull bears to the face, and the relative lengths of the upper and lower extremities. In the Caucasian the skull is rounded, the forehead raised, and the facial portion small in proportion to it. In the Mongolian, the upper and lower extremities are small, the cranium more of a square form, the forehead inclined, and the face large and flattened; the malar bones being especially prominent. In the Negro the proportions of the skeleton are smaller in the lumbar and pelvic regions; the upper extremities are long in proportion to

the body, and the forearm and leg are large in proportion to the arm and thigh; the hands are small, the feet wide and flat, and the ossa calcis project much backwards. The skull is narrow and elongated, the forehead small and compressed, the malar bones and jaws project, and the teeth are placed obliquely, so as to form a considerable angle at their point of union. The most marked characteristics exist in the configuration of the skull; but the skull of Ho Loo (a Chinese), in the Guy's Museum, scarcely possesses the characters assigned to the Mongolian; it closely resembles the skull of the Caucasian. That of the Negro may be more clearly identified. The skull of the Hindoo is a mixture of the Negro and Caucasian. It would be difficult, if not impossible, to pronounce an opinion of the race to which the skeleton belonged, from a few detached bones or parts of bones.

Identity from fractures.—With regard to other circumstances connected with the skeleton, it will be proper to observe whether the bones belong to the same or different individuals, to the right or the left side of the body; and these questions may be determined in many cases by the mere inspection of fragments. The existence or non-existence of *fractures*, and the progress which may have been made towards ossific union, may also become an important subject of inquiry. In general the past existence of a fracture is easily determined in an exhumed bone, by the appearance of a knot or ridge, or in some cases a thick deposit of bone where union has taken place badly. In a fractured bone which has united in a curved form, it will be observed, on making a section, that the shell is considerably thicker on that side which has had to bear the greatest weight or pressure. All these facts, trivial as they may appear, may in reality be material in a case of disputed identity; and unless carefully observed at the time, valuable evidence may be lost.

An English gentleman residing in India, 1833, was charged with the murder of a native, *Meer Khan*. The evidence against the prisoner was of a twofold character: 1, that which preceded death, and 2, that which followed it. With regard to the first, it will be only necessary to refer to it briefly. There was great discrepancy in the statements of the witnesses, as to the manner in which the deceased was alleged to have been destroyed. It was shown that the deceased had received a beating at the hands of the accused, but it was not proved that the man had died in consequence of the beating. There was no effusion of blood; there were no marks of violence of any kind upon the body before or after death, unless, indeed, we except a burning of the skin of the legs, which was alleged to have been produced by burnt paper or straw, but the evidence respecting this was anything but coherent and conclusive. Be that as it may, however, there was no evidence to prove that the alleged burning was the cause of the man's death. Two of the men (natives) who said they carried the dead body to be buried at midnight, testified to the presence of marks of burning, but contradicted each other respecting the appearance of the legs; one swearing that they were covered with plasters, the other that the wounds and burns were not covered. The latter witness prevaricated, and, when asked how he knew that the legs were burnt, replied that he judged so from their being *white*.

The testimony respecting the degree and effects of the violence applied to the deceased during life being so inconclusive, it was left to the jury to decide whether a quantity of human bones produced were those of the deceased, as it was alleged by the witnesses for the prosecution, or whether they belonged to the skeleton of some other person. According to the depositions, they were found in the following manner. *Three months* after the burial, one of the witnesses who had assisted in burying the deceased, after some search, discovered, as he supposed, the grave, on the verge of the bank

of the river Damoodah. The body, it seems, had been buried pretty deeply in the sand, above the common water-mark, at the distance of sixty or eighty yards from the bed of the river, at a place which the waters had never reached, or could reach only on extraordinary occasions. The bones were uncovered, but not removed, until five days afterwards. It does not seem to have been clearly made out whether other bodies were ever interred in that spot or not, nor was the grave properly identified as that of the deceased. The bones were subsequently examined by Mr. Cheek, a medical officer attached to the station of Bancoorah. He stated in his evidence that twelve of the vertebræ, six of the ribs, and the sacrum, were wanting; that the whole of the bones found were clean and dry, and free from periosteum, ligaments, and cartilage; that *one rib was broken*, and apparently had an osseous callus (new bone) formed upon and around the fractured ends. The witness gave it as his opinion that the fracture must have occurred at least seven or eight days before death; he had never heard of an instance of exhumed bones being deprived of soft parts and ligaments by natural decomposition in three months. He should not expect the cartilages and ligaments to be separated from the bones within a year of the interment; he considered it, therefore, extremely improbable that these were the bones of the deceased, or of any person who had died within three months from the time of examination.

From this evidence, as the reporter of the case remarks, several considerations suggest themselves; as, for example, the identity of all the bones as those of one individual, the age of the person, the nature of the bony excrescence or callus found on the broken rib, the time necessary for the formation of new bone in order to settle the period at which the fracture took place, the time required for the total spontaneous destruction of the muscles, tendons, ligaments and viscera; also the time required for the spontaneous separation of the sacrum from the other bones in a man of the age of fifty or sixty. Many of these points, important as they were, were altogether passed over. The witness gave it as his opinion, that they were the bones of a *male* subject; but of this, he said, he could not be quite certain as the sacrum was wanting. No opinion was asked or given as to the supposed *age* of the person to whom the bones belonged. Only one bone was produced in Court, viz. the broken rib, with the deposit of callus (new bone) at its extremity. From the state of this callus there could be no doubt, supposing the bone to have belonged to the deceased, that the *fracture* must have been produced about eight or ten days before death; therefore at some time previous to the violence employed by the prisoner. The non-identity of the bones as those of the deceased, seems, however, to have been clearly established by the condition in which they were discovered. Even in a tropical climate the period that must elapse before the total destruction of the soft parts of the body in a grave, so that nothing but the bare bones shall remain, must be considerably greater than three months. In one instance, in which a body was exhumed four months after death, the soft parts were still present.

Another curious feature in the evidence was the separation of the sacrum from the bones of the pelvis. The junction of these bones by ligaments and fibro-cartilage is perhaps one of the strongest in the body. In the skeletons of the young these bones are rather difficult of separation; but in the old, in whom anchylosis (or bony union) in general takes place to a greater or less extent, the difficulty of separating them become incomparably greater. It may readily be conceived, then, that the entire separation of this bone by decomposition, would require, even in a hot climate, an extremely long period in a body interred in the ground—probably from three to ten years. Now, when we consider that the deceased had not been buried above three months, it is clear, both from the entire destruction of the soft parts, and the

separation of the sacrum, that the bones discovered on the bank of the river could not have belonged to the deceased, but must have been part of the skeleton of a person whose body had been buried in the spot many years before. There was, therefore, a complete failure of identity, and the accused was discharged.

Identity from disease or deformity.—Questions of identity in relation to skeletons may be in some cases solved by reference to certain special characters of the bones. They may have about them indications of disease; as rickets, softening of the bones, or syphilis. There may be, again, some personal peculiarities, such as the presence of supernumerary fingers or toes, which, if observed, may tend to throw some light upon the case. An instance of this kind is mentioned by Orfila. In the year 1823, a man named *Bonino*, who had been residing in a small village in the neighbourhood of Montpellier, suddenly disappeared. It was some time afterwards reported that he had been murdered by a girl with whom he had cohabited, and by a man of the name of Dimont, who was known to have been for some time her associate. It was only in the year 1826, after the lapse of more than two years, that the magistrates were first induced to direct an investigation of the case. A strict search was ordered, and the remains of a body, chiefly the bones, were found buried in the garden of Dimont, who had married the girl nine months after the disappearance of Bonino. It was of course essential to identify this skeleton as that of the deceased. It was well known that he had laboured under a singular personal deformity in having a sixth finger on the right hand, and a sixth toe on the left foot. The bones, which were nearly all perfect, were carefully removed and put together, when it was found that those belonging to the two smaller toes of the left foot were wanting; but the metatarsal bone of the fifth toe had a process on the outer side, with a small articulating surface, which might have formed a supernumerary joint. Still, however, this was considered insufficient to establish the point, and the attention of the examiners was then directed to the right hand. The fifth bone of the metacarpus was shorter and broader than the one belonging to the opposite hand, while its digital extremity was divided into two parts, of which one formed a smooth, rounded, articulating surface in the axis of the bone; while the other, which presented a more flattened articular surface, formed with it an angle of about 8°. On attempting to articulate the first phalanx of the little finger, it fitted exactly the first articular surface, and presented on the outer side a distinct groove, the oblique direction of which coincided with the direction of this second surface. This left no doubt of the nature of the peculiarity of structure; although the phalanges of the sixth finger could not be discovered. The left hand and the right foot were complete in all their parts. Other corroborating circumstances transpired with respect to the marks of violence on the body, and the two prisoners were tried, condemned, and executed. (For other cases see 'Ann. d'Hyg.' 1863, 2, 114.)

Deformities of the spine or limbs are easily observed, and may form well-marked points of identity. Briand mentions the following case. In 1825 a man named *Guérin* suddenly disappeared. Three years afterwards an excavation was made in the cellar of the house where he and his brother had resided, and some human bones were discovered. Among other circumstances, the medical men to whom the examination of these bones was referred, remarked that the body of the fifth lumbar vertebra was depressed and thin as it is met with in rachitic individuals, that the pelvis was more contracted on the left than on the right side, that the tibia and fibula of each leg presented a remarkable curvature, greater, however, on the left than on the right side, so that the left leg was half an inch shorter than the right. There

were certain peculiarities about the teeth of the lower jaw, the cuspidati forming a considerable projection in front of the incisors. These facts, together with other circumstances, established the identity of the bones, as being those of the person who had been missing for a year.

The bones of the skull in children may occasionally present appearances arising from natural causes, but which may simulate the effects of violence applied to the head. The following case of suspected child-murder was examined by Mr. Lord and myself in 1847. The dead body of a new-born child, wrapped in brown paper and a towel, was found in a pond. Mr. Lord examined it for the coroner's inquest. The head was much decomposed, and the scalp was extensively lacerated and destroyed over the parietal bones, which readily separated. The brain was reduced to a bloody pulp. The umbilical cord, which had not been tied, was cut obliquely at about six inches from the navel. The lungs, which were very crepitant, readily floated on water, and bore up the heart. The body was generally bloodless. The point of difficulty which the case presented consisted in the presence of two apertures on one parietal bone. These apertures were small and rounded, and it was at first doubtful whether they had not been wilfully produced by some perforating instrument applied to the head. It was remarked that one aperture was situated near the temporal ridge, and in this situation the scalp was entire and uninjured. The other was situated in that part of the bone which corresponded to the lacerated portion of the scalp. It was ascertained that no violence had been used in the removal of the body from the water. The bone was macerated, and carefully examined by the aid of a lens. It was then perceived that the apertures were quite regular at the edges, which were remarkably thin, evidently passing into a membranous condition. The internal table was also deficient, so that, from the interior, the bone was bevelled off gradually from each aperture. This examination left no doubt that the holes in the bone were not due to any mechanical violence applied during life, but to deficient ossification. These spaces had been membranous, and the membrane destroyed by decomposition. The putrefaction of the scalp, and its separation, might have been accelerated by a bruised condition of these parts during a difficult labour. In examining a skull, disinterred under suspicious circumstances, natural defects in the bones must not be mistaken for apertures made by deadly weapons. These natural defects are generally well characterized. They may be found at all ages. Dr. W. Turner has described and figured some of these cases of defective ossification. (See 'Ed. Med. Jour.' Aug. 1865, p. 133.) These apertures from defect are generally characterised by rounded and regular margins. They are not rough and irregular, like those produced by the violent use of weapons.

The bones which we are required to examine may have undergone *calcination*. In several cases of child-murder which have occurred, an attempt has been made to dispose of the body by burning it. This method of disposing of a dead body is by no means unusual in cases of alleged infanticide and concealment of birth. There will be no great difficulty in giving an opinion whether a bone has or not undergone calcination. Its character is entirely altered. Its shape may be preserved, but if burnt in the open air, it will be white; if in a close fire, it will be black or ash-grey. The bone is brittle, easily pulverisable, and dissolves entirely in hydrochloric acid, leaving, if perfectly calcined, only some charcoal but no animal matter.

In the case of *The Queen* v. *Varney* (Oxford Lent Assizes, 1837), it was proved that the woman had been pregnant, and subsequently delivered of a child. Its body had been burnt, and only a few remains of the bones of a human fœtus were found in the ashes of a grate. The prisoner was convicted of concealment of birth. In a case like this, in which an attempt had been

made to destroy the body of a child by burning, it will, of course, be necessary to have good evidence that the bones are those of a *human fœtus* or child. A small fragment only of either end of any well-marked bone will suffice for identification. If the jaws be forthcoming, the alveolar cavities should be sought for, and the number and condition of the teeth noticed. The period of uterine life which the child had attained may be thus in some instances determined. For two cases in which age and identity were thus proved, see 'Gazette des Hôpitaux,' April 26, 1850.

If the body has been burned to a complete ash or powder, it will then be difficult to identify the bones. Orfila was consulted in a ease of this kind, where a woman had burnt a child in an oven, and its ashes had become mixed with those of wood. He suggested that on calcining the residue with potash, the ashes of a human fœtus might be known by their yielding cyanide of potassium, owing to the nitrogen which would remain in and about them. The ashes of wood do not yield the cyanide under similar circumstances. ('Ann. d'Hyg.' 1845, 2, 129.) The conclusions drawn under such circumstances might, it appears to me, lead to a serious error:—the presence of a flannel dress, of an old hat, shoe, or any nitrogenous substance, would, on incineration, give rise to precisely similar results. When the *form* of a bone cannot be recognized, all that medical evidence can accomplish may be thus stated:—The detection of a large quantity of *phosphate of lime* in the ash would indicate that bones were present, and thus distinguish the ash of bone from the ashes of other substances. Still the bones might have belonged to an animal, and not to a human fœtus. There are no means of distinguishing the ash of human from that of animal bone, or the ash of fœtal from the ash of adult bones. In the case of the *Lemoines*, mother and daughter, tried before the French Courts in December 1859, the evidence went to show that the elder prisoner (the mother) burnt the body of a child of which her daughter had been secretly delivered. Some bones of a child were recovered, and among others the frontal bone. The medical evidence was to the effect, that the bones were those of a child which had reached about the seventh or eighth month. Upon this corroboration, the jury convicted the elder prisoner, and the Court sentenced her to twenty years' imprisonment.

In a case of concealment of birth tried at the Guildford Summer Assizes, 1854 (*Reg.* v. *Berryman*), it was proved by medical evidence, that the prisoner had been recently delivered of a child, not less than seven months of uterine age. She said that she had burnt the body to conceal her shame, and had buried the remains in a garden. Some bones which had been calcined were there found buried in ashes; and after an examination of them, a medical man stated that they were the bones of a child nine months of age; but in comparing them with the skulls of nine months' children in Museum collections, it was admitted that the skull, of which the parts had been found and restored, was larger. This admission threw some doubt on the identity of the bones, and the prisoner was discharged.

In January 1863, a man named *Barton*, a fireman employed at a coal pit near Wigan, was missing. From the appearance of blood about the mouth of the steam furnace, and the discovery of a burned portion of the dress worn by the deceased, there was reason to believe that the man had been murdered and his body thrust into the furnace. Dr. Edwards examined the ashes of the furnace and found:—1. Portions of the occipital bone of the human skull; 2. Base of the skull and two fangs of teeth, a fang of an incisor and a fang of a molar tooth; 3. Portions of the arches of the dorsal vertebræ; 4. A portion of the lumbar vertebræ; 5. A portion of the head, body, and joint of the humerus; and 6. A portion of the head and joint of the femur or thigh-bone. These bones had been heated to a high temperature, which had des-

troyed their internal structure, but the external form was well preserved. They were human bones. A chemical and microscopical examination of some of the clinkers showed that there was blood upon them, having the character of human blood. There was no doubt that these were the remains of the missing man. He was last seen alive at eight in the evening, and at four the following morning nothing remained of him but the few bones above mentioned.

In the exhumation of remains, portions of *hair* may be found on or about the skull, or in the earth surrounding it. The hair should be separated by washing it first in water, and afterwards in a mixture of distilled water and diluted acetic acid. When dried on paper the colour will be observed, and this may be of some value in determining a question of identity. French medical jurists lay great stress upon the necessity for determining whether the hair has been artificially dyed or not. The common hair-dyes are compounds of lead, silver, or bismuth; and these metals, when the necessity arises, may be sought for and easily found by processes similar to those required for their detection as poisons when absorbed into the tissues. This will be a matter for future consideration.

CHAPTER 9.

CAUSES OF DEATH—SUDDEN DEATH—SYNCOPE, ASPHYXIA, COMA—PRESUMPTION OF DEATH—MEDICAL EVIDENCE OF PRIORITY OF DEATH IN CASES OF SEVERAL PERSONS PERISHING FROM A COMMON CAUSE—PRESUMPTION OF SURVIVORSHIP.

MEDICAL jurisprudence takes cognizance of all violent causes of death, and is only indirectly involved in those cases of natural death which simulate the effects of violence. Thus all causes which operate to produce death suddenly, as by syncope, asphyxia, or coma, especially demand the attention of a medical jurist. These may be either natural or violent; and the distinction between them is of importance, since the guilt or innocence of a person charged with crime may depend on a correct determination of the cause.

The continuance of life depends upon the proper and regulated action of the heart, the lungs, and the brain; and the interdependence of these organs is such that the arrest of the functions of one of them, is speedily followed by the arrest of the others. Hence they have been called the tripod of life. When the suspension of the motions of the heart is the primary cause of death, the person is said to die by syncope. The term asphyxia is applied to death which begins by the lungs; and coma to that which arises from a primary disturbance of the functions of the brain.

SYNCOPE (συγκόπτω, signifying 'to cut down').—In order that the action of the heart should be maintained, it is necessary, first, that the blood supplied to it should be in sufficient quantity, and secondly that this blood should be of proper quality. In death from hæmorrhage we have an instance of deficiency, and in death from certain poisons, as well as diseases, an illustration of defect of blood. In ordinary syncope (fainting or swooning) there is simply a deficiency in the quantity of blood which passes through the heart, although there is no actual loss of this fluid from the circulation. Certain diseases which affect the muscular structure of the heart, as well as the membranous valves and blood-vessels, may also lead to a sudden arrest of its functions. These morbid conditions produce a mechanical impediment to the motions of

the organ by which the blood is propelled, and death by syncope is the necessary result.

When death takes place by the heart, the right and left cavities of this organ are found to contain blood in the normal proportion in which that fluid is ordinarily circulated. This retention of blood in these cavities, arises from the sudden stoppage of the heart's contractions. Blood is found in the large veins (venæ cavæ), as well as in the arterial trunks. There is no congestion or accumulation of blood in the lungs or the brain.

Asphyxia (ἀ priv. and σφύξις pulse, signifying pulselessness).—This state is induced by any cause which arrests the function of respiration. The term apnœa (from ἀ priv. and πνέω I respire) is more appropriate; for the state of syncope might for a similar reason be called asphyxia. The various forms of death by suffocation, as in the obstruction of the air-passages from mechanical causes, in drowning, hanging, and strangulation, furnish illustrations of death commencing by the lungs, or asphyxia. The effect of cutting off air from the lungs is that the blood is not aërated, and it is therefore circulated in a state unfitted to support the nutrition of the heart and brain. It is necessarily distributed with the impurities derived from the waste of tissue, and thus acts as a poison to all the organs. It is incapable of sustaining nerve-force or muscular irritability. It stagnates in the capillary vessels of the lungs, produces a languid action of the heart by its circulation through the muscular structure of this organ, and it produces insensibility by its distribution through the blood-vessels of the brain. The lungs are essential to the circulation by purifying the blood. Death from asphyxia may be therefore regarded simply as death from *defect* of blood. The observations of the late Sir B. Brodie ('Lectures on Pathology,' 66) and others have clearly proved that in spite of the impurity of the blood, the heart will continue to act and the circulation to be maintained for two or three minutes or longer after respiration has entirely ceased. This may be proved by hanging or strangling an animal, and observing the condition of the heart. As the action of this organ continues after the animal has ceased to breathe, life is not actually extinct; and under favourable circumstances, it may be restored, so long as this action continues. Supposing that the suspension of respiration is complete, the action of the heart gradually slackens and finally ceases. It is at this period of the complete arrest of the motions of the heart that asphyxia passes into death. Apnœa is determined by the time at which respiration is completely arrested. The circulation of the unaërated blood through the brain appears to annihilate sensibility, so that no consciousness or feeling exists: the person is, to all appearance, dead. There are many diseases which operate fatally by arresting the functions of the lungs, and these may be regarded as furnishing the natural causes of asphyxia. The violent causes, including not only the ordinary modes of suffocation, but the effects of certain poisons, are not difficult to appreciate, provided a true history of the case can be obtained.

In death by the lungs, as the circulation of the blood is primarily arrested in these organs, the pulmonary artery, the right cavities of the heart, and the venæ cavæ are found gorged with blood. The pulmonary veins, the left cavities of the heart, and the aorta, are either empty or contain but little blood. In certain cases of asphyxia, the right cavities of the heart, as well as the left, have been found empty. When the access of air to the lungs is suddenly and completely cut off, the circulation of the blood is speedily arrested; but supposing the occlusion of the air-passages to be partial or gradual, the circulation of the blood may continue for a time, and thus cause congestion of certain organs. Hence the appearances in asphyxia differ greatly. A

mixed condition under the name of syncopal asphyxia has been described by some pathologists. In this, the cavities of the heart are found empty.

Coma.—Besides a due supply of aërated blood, the brain requires for the exercise of its functions a proper quantity of blood, so that either by the sudden withdrawal of this fluid, or by a distribution of impure blood, these are arrested. A person thus affected falls into a state of complete insensibility (coma), so that it is impossible to rouse him. The functions of the heart and lungs are not suddenly arrested under these circumstances. They appear to be less dependent on the brain than the brain is upon them; but this is rather a question of degree. A due supply of nervous force is required for the action of the muscles, whether of the heart or of the chest; and when this is withdrawn, the heart ceases to pulsate, and the respiratory muscles cease to act: circulation and respiration are thus arrested by the absence of innervation. This is sometimes described as death by paralysis of the heart and lungs. The blood is neither aërated nor circulated. Sudden death from apoplexy is an illustration of death by the brain. Coma may also be a result of the introduction of certain poisons into the blood, and of fractures of the skull leading to compression of the brain or destruction of its substance. In death by the brain, the appearances observed consist chiefly in a congested state of the cerebral membranes and substance of the brain. As, before death, respiration is affected, the lungs are congested, and blood accumulates in the cavities of the heart, more on the right than on the left side. The appearances described as characteristic of the different modes of death by the heart, lungs, and brain, are liable to variation by reason of the intimate relation of the organs. Thus, there may be a mixed condition of syncope and asphyxia, or of asphyxia with cerebral congestion.

With regard to the interruption of the functions of the brain as a result of pressure by the effusion of blood or serum, it is to be observed that a very small quantity effused at the base or in the substance of the medulla oblongata, is sufficient to cause death; while generally speaking a larger quantity is required to be effused in the membranes, ventricles, or substance of the brain in order to produce a fatal result. In cases of chronic hydrocephalus, in which the brain has resisted the pressure of a large accumulation of serum for many years, a slight and sudden increase in the quantity at any period of life may lead to coma and death by apoplexy. This condition may be mistaken for narcotic poisoning.

All causes of death, whether from disease or violence, are referable to an effect produced primarily on the heart, the lungs, or the brain; but, as it has been elsewhere stated, death does not take place until the action of the heart has entirely ceased. The arrest of the circulation produces an immediate impression upon the functions of the brain and lungs; while the lungs and brain are affected and can only affect each other indirectly through the medium of the circulation: hence, systemic death, or the death of the body, is resolvable into death by syncope or a failure of the action of the heart, and this depends in all cases either upon defect or deficiency of blood.

The natural causes of *sudden death* may be generally traced to some injury or impediment to the action of the heart, lungs, or brain. It would be foreign to the objects of this work to give a description of them. The violent causes are those which demand the especial attention of a medical jurist; they will be considered hereafter. In its relations to medicine and medical jurisprudence the subject of sudden death has been most fully treated by Herrich and Kopp ('Der plötzliche Tod aus inneren Ursachen,' Regensburg, 1848); as well as by M. Devergie ('Ann. d'Hyg.' 1838, 2, 145). To these works I must refer the reader for further information on the causes, as well as on the

appearances met with in the bodies of persons dying suddenly from natural causes.

The *violent* causes of death, whether sudden or protracted, which chiefly require the skill of a medical jurist for their elucidation, are poisoning, wounds, and personal injuries, such as burns and scalds, as well as those forms of death which commence by the lungs, including drowning, hanging, strangulation, and suffocation. In nearly all cases, the body of the deceased is produced, and a medical opinion can be based upon a careful examination.

Presumption of death.—Before proceeding to describe these violent causes of death in their order, it may be well in closing this part of our subject to state that the fact of death may be proved by presumptive, as well as by direct evidence. The death of any person once shown to have been alive, is a matter of fact to be determined by a jury; and when the body is not forthcoming, as the legal presumption is in favour of the continuance of life, the onus of proving the death, lies on the party who asserts it. (Best on 'Presumptions of Law and Fact.') When a person goes abroad and has not been heard of for a long time, the presumption of the continuance of life ceases at the expiration of seven years from the period at which he was last heard of. The same rule holds generally with respect to a person who has gone away from his usual place of resort, and of whom no account can be given, but the presumption does not extend to the *time* of his death, *i.e.* whether he died at the beginning or at the end of any particular period of the seven years. In the case of *Watson* v. *England*, which came before the Court of Chancery some years since, it was attempted to enforce as a presumption, that a female who had left her father's house in 1810, and had not been heard of for thirty-four years, was dead. No decision was come to, the Vice-Chancellor observing, from the great uncertainty of the evidence, that if he presumed her death, the woman might walk into Court and disprove all. In one case, according to Best, the Court of Queen's Bench said, that they could not assume judicially that a person alive in the year 1034 was not alive in 1827! (Op. cit. p. 190.) Without adopting this extreme legal view of possible longevity, it is obvious that Courts of Law may be easily deceived if such presumptions are admitted too readily. In *Church* v. *Smith* (Exchequer, Dec. 1853), the question was whether plaintiff was then a married woman, or whether by reason of the long absence of her husband, his death might not be legally presumed, and that she was, therefore, a widow, and could sue in her own right. According to the statement of her counsel, she was married to a man who had deserted her fourteen years ago, and she had heard nothing of him during the last twelve years. An end was put to the case by the appearance, in the witness-box, of an aged man who turned out to be the missing husband. The plaintiff, therefore, not having the power to sue in her own right as a widow, was nonsuited, the Chief Baron observing to the jury that he should have directed them to presume that the husband was dead, if, as the counsel stated, it had been proved that he had not been heard of for twelve years; but after his appearance in Court, he could not ask them to presume a man to be dead who was actually living before their eyes! In *Reg.* v. *Briggs* (Nov. 1856), a woman was deserted by her husband four months after marriage, and he had been absent from her seven years. The woman married again in her maiden name; and on an indictment for bigamy, it was contended in her favour that the husband had been absent for the period above mentioned, and the prisoner had no knowledge of his existence. She was convicted, but the conviction was quashed on appeal. In a case before V.C. Malins (Jan. 1869), (*Re W. Beasney*), the person whose death was in question was last seen in August 1860. He was then suffering

from pulmonary disease, and was much emaciated. He announced his intention to go to New York, but to return before October. He was never afterwards heard of. The petitioner was entitled to the principal of the legacy in the event of the death of W. Beasney before the 7th Nov. 1860, and contended that he must be presumed to have died before that day as, although in needy circumstances, he had not applied for the dividends then due to him, and that when last seen he was in a precarious condition of health. On the other side it was asserted that the onus of proof was on the petitioner, and no proof of death had been given. The Vice-Chancellor decided in favour of the petitioner that Beasney died before the 7th Nov. 1860, chiefly on the ground that he had punctually applied for and received the dividends on an annuity up to the time of his disappearance. None had been applied for since that time, and ten years had elapsed.

Great injustice would be done unless some rule were adopted regarding the disposition of the property of those who have been long absent, and not heard of for many years. In the case of *Davy* (Probate Court, 1858), it was proved that the testator was a master-mariner. He made his will on December 2, 1856, and sailed for Melbourne from Southampton in December of that year. He then made a voyage to Calcutta, where he arrived in October 1857, and in the following December cleared from Calcutta for Port Louis in the Mauritius. His vessel never arrived at her destination, and nothing had been heard of her since that date. The correspondent of the owners of the vessel at the Mauritius, had from time to time reported her non-arrival. This was considered sufficient to establish a presumption of his death, although not more than two years had elapsed since his departure from England; and probate of the will was granted.

In *Green* v. *Green* (Vice-Chancellor's Court, July 1861), a question was raised whether a person who had not been heard of for upwards of eighteen years must be presumed to have died. The testator in the cause, who died in August 1838, by his will, dated in April 1838, gave an annuity of 30*l.* to his son, James Green, and upon the death of such son, the testator gave 750*l.* to the children of James Green, and if he should die without leaving children, then the testator gave such sum of 750*l.* to the brothers and sisters of James Green who should be living at his (James Green's) death. In September 1840, James Green left this country for New South Wales, and he had not been heard of since February 1, 1843, when he wrote a letter acknowledging the receipt of the last payment of the annuity of 30*l.* Edward Green, one of the brothers of James Green, died on January 25, 1846, and the question was, whether the absent James Green must be presumed to have died before or after his brother Edward Green. On the former presumption Edward Green's representatives would be entitled to a share of the 750*l.*; and on the latter presumption, they would not be so entitled. The bill was filed by one of the children of the testator, who was interested in the presumption that James Green had died after his brother Edward, and in that state of circumstances, the Vice-Chancellor ruled that the burden lay on the plaintiff to show that James was alive at the death of his brother Edward. As above stated, there was nothing to show that James Green had been heard of since February 1, 1843. A decree was made to the effect that James Green must be presumed to have died before Edward Green, and that the fund should be distributed upon that presumption.

A remarkable case was tried in the Court of Exchequer, Guildhall, in February 1862 (*Hiorns and Drew* v. *The Railway Passengers' Insurance Company*) which involved a question of the presumption of death from circumstantial evidence; but in which it was suggested that a grave fraud had been perpetrated by the parties concerned. The action was to recover

from defendants the sum of 250*l.*, on a policy of insurance on the life of one *F. D. Hiorns.* The alleged deceased, Hiorns, was a single man, æt. 26. He insured his life against accident, for the above-mentioned sum, on the 6th September, 1856; and on Saturday the 13th September, he went to Brighton by an evening train, taking a return ticket. He spent Sunday and Monday with his friends, and on the morning of the latter day (the 15th) he had a bath in the sea; in the evening he parted from his friends, at about seven o'clock, to go to his lodgings before returning to London, expressing his intention of taking a second bath before doing so. He was seen to go towards the sea, and from that time up to the date of the action he had not been seen alive. On the day that he was missing, a person discovered a suit of clothes lying on the top of the steps of a bathing machine, but no trace of the owner of them could be discovered. The police took possession of the clothes, and upon searching the pockets a purse, containing a return-ticket, was found, and they were identified as belonging to Hiorns. Advertisements were issued, and every inquiry made to discover the missing man, but without avail. On the 30th of October, forty-five days after the disappearance of Hiorns from Brighton, the naked body of a man was washed up at Walton-on-the-Naze, on the Essex coast, about 150 or 160 miles from Brighton. The body, according to the opinion of some medical men, had been in the water some six or seven weeks, and it was, of course, very much decomposed, all traces of the features being destroyed. An inquest was held, at which the plaintiff, G. B. Hiorns, attended, giving evidence that the remains were, to the best of his belief, those of his brother. In consequence of the complete destruction of the features, according to the medical evidence, there was nothing whatever on which to base a proof of identity, and the jury found that it was the body of a person unknown. The defence to the action was: that the assured was still living and within reach of his friends, awaiting the receipt of the money from the Office. It seems that the alleged deceased had been a bankrupt in 1855; and in September 1856, he effected several policies of insurance in different Offices, and made his will, directing that the policies after his death should be realised and the money appropriated to the payment of his debts. The jury could not agree, and were discharged without a verdict. As in this case the body of Hiorns was not found, there was no direct proof of death. The discovery of the clothes was only a circumstance from which a presumption might be raised either way. Considering that the man's life had been insured in this and other Offices for only one week, at the time of this mysterious disappearance, there was strong reason for suspicion.

In September 1866, a merchant of Bordeaux, named *Vital Douat*, who had become bankrupt, endeavoured, in collusion with his wife, to defraud an Insurance Company of Paris. Shortly before his bankruptcy he insured his life for 100,000 francs. He was subsequently declared a fraudulent bankrupt, when he suddenly disappeared, and about a month afterwards his wife presented to the Office a certificate purporting to be a copy of the register of the death and burial of her husband in England, and claimed the amount for which his life had been insured. A full investigation in this country led to the discovery that the man had passed under various names; had purchased a coffin; procured a certificate from a Registrar of Deaths, recording his own death in a circumstantial manner; and had followed to the grave in a churchyard in Essex, the coffin which was supposed to contain the body of himself, the missing bankrupt. Under an order from the Secretary of State the coffin was exhumed. It contained only a mass of lead, evidently placed there to give it weight. The man fled the country, but was subsequently captured at Antwerp and delivered to the French authorities. The possibility of such a

case as this occurring, shows that our system of registration of deaths is fallacious. It has long been known that a wrong cause of death might easily be assigned by an ignorant or interested person, but this and some other cases prove that a living person may register himself as dead, and a fraudulent use be made of the certificate thus procured!

It is obvious that such cases can be elucidated by medical evidence only when it is proved that the missing party was labouring under some serious disease, likely to prove fatal, for which he may have received medical advice; an opinion might then be required as to the degree to which the disease had advanced, and the probability of its causing death within a certain period. No general rules can be laid down; every case must rest upon the circumstances which accompany it.

A presumption of death may arise in a question of life assurance, as when, for instance, the amount of a policy is made payable on the death of a person. He may have sailed in a ship which has not been heard of for many years; and from circumstances it may appear to have been overtaken by a storm in which other ships were lost. In such cases, payment is commonly made under a deed of indemnity. If the case be disputed, the presumption of death is left as a question for the jury. A verdict was returned for the plaintiffs in an action to recover a sum insured on the life of a Mr. Macleane, the evidence being that about November 28, 1777, the insured sailed from the Cape in a small sloop, and was never heard of afterwards. Several vessels of a stronger build sailed at the same time, and they encountered a violent storm in January 1778, in which it was supposed the sloop was lost. It is clear that unless a presumption of death were allowed in such cases, injustice would be done to the representatives of persons who had insured their lives.

Priority of death. Presumption of survivorship.—Let us now take the case that several persons have perished together from some common cause; it may be material to determine which probably survived the other, since property may be claimed by different heirs through the several deceased persons. According to the civil law, when the parties who perished together were parent and child, the latter, if under the age of puberty, was presumed to have died first, but if above this age, the rule was reversed. In the case of husband and wife, the presumption was in favour of the survivorship of the husband. These presumptions were based on the assumption that the party deemed to have survived was, by his superior strength and vigour, likely to have struggled longest against the common death. The law of France is in some measure based upon these provisions; but in England there is no absolute rule on the subject. The question,—Which of two parties survived the other, is left to be determined by a jury or judge, according to the facts proved; such as the comparative age, strength, and danger to which they were respectively exposed, and any other circumstances capable of proof which are calculated to throw light upon the case. It has, however, happened on several occasions, that there have been no such indicia, and the case has then generally terminated by a compromise of the suit. There is a well-known instance which is referred to by most medico-legal writers, that of *General Stanwix*, in which the General, with his second wife and a daughter by a former marriage, sailed in a vessel from Dublin to England. The ship with all on board was lost at sea, and no account of the manner of her perishing was ever received. Several suits arose out of this accident. The maternal uncle of the daughter claimed the effects of the General, under the principles of the civil law. This case was not decided: the suit was compromised on the recommendation of Lord Mansfield, who said he knew of no legal principle on which he could decide it. In another case, Sir W. Wynne said, that in his judgment, the most rational presumption was that all had died together;

and that, therefore, none could transmit rights to another. In a third, where husband and wife were drowned, and a claim was made by the wife's relations, Sir J. Nicholl said he assumed that husband and wife perished at the same moment; and he therefore granted administration to the representative of the husband, as the person in whom the property really vested at the time of the decease of both. He, however expressly observed that in giving this judgment, he was not deciding that the husband actually survived the wife.

In a more recent case, the property was vested in a wife, and she and her husband were drowned together without any of the circumstances being known. A claim was made by the husband's heirs, on the presumption that he was the survivor. Sir Herbert Jenner decided according to the principle that where a party dies possessed of property, the right to that property passes to his next of kin, unless it be shown to have passed to another by survivorship. Here the next of kin of the husband claimed the property which was vested in the wife; that claim must therefore be made out: it must be shown by him that the husband survived. In the absence of evidence, the parties must be presumed to have died at the same time, and the property therefore would remain where it was vested, unless there was evidence to show that it had been devested by survivorship.

Some years ago the following question was referred to me for a medical opinion:—whether it was likely, in the drowning of persons of different ages and sexes, in a confined apartment (the cabin of a vessel), that one should have survived the other. An officer in the army died in November 1819, leaving a wife and two daughters, bequeathing property among them. In 1823, the widow married again, and by this second marriage she had several children: one of these, a son, survived. One of the daughters by the first marriage, Margaret, died in 1825, before majority, intestate, and leaving only as next of kin, her sister Johanna and her mother. In 1834, the mother, her daughter Johanna, and her son, the last surviving child of the marriage between her and her second husband, were drowned on the coast of Norfolk, in the cabin of a sailing-packet, while on their way to Scotland. The vessel filled with water from the skylights of the cabin during a storm. A few minutes before the catastrophe, all in the cabin were seen and spoken to, but not one of them was heard to speak or was seen alive after the cabin had become filled with water, which was said to have happened instantaneously. The deaths of the mother, daughter and son were supposed to have taken place at one and the same instant of time; at least it could not be proved by the direct testimony of any person that he saw any one of the three alive, or that he heard the cry or speech of any one of these three, after the death of the other or either of them. It may be mentioned that the mother was corpulent, and, by the ill-treatment of her husband, a broken-hearted woman, about forty-two years of age; the daughter was a stout healthy girl of about twenty, and the son about six years of age. Physical and constitutional strength were thus decidedly in favour of the survivorship of the daughter Johanna, who was in right of considerable funds at the time of her death, and she died intestate. A claim was made for her property by her nearest blood relation, her paternal uncle-german. Her mother's second husband being still alive, claimed the property, as the representative of his wife, or his son, presuming that Johanna died before them, and that her property became vested in them. The opinion of Dr. Lushington being requested on this case, he stated that as to the question of survivorship, the presumption of law, in the absence of evidence to the contrary, was that the mother, daughter, and son all died at the same moment. The consequence would be, that none of the parties could transmit to the other. The paternal

uncle would therefore be entitled to Johanna's property, on the principle already applied in so many cases, that the property being vested in her, those who desire to take it on a presumption, must produce evidence to show that she died before those persons through whom they set up a claim.

In this case there was not the least ground, medically speaking, for assuming that one of these persons survived the other. There was no evidence as to whether they were in different parts of the cabin, or whether the water reached one before the other; and in the absence of all facts of this kind, it would be an arbitrary assumption to assign survivorship to one.

It has been supposed that when males and females, and the young and aged, are placed in exactly similar circumstances with regard to impending danger, that a male or adult would survive; but on what principle can such an inference be drawn, when many inappreciable circumstances may have really led to the prior death of the male adult? A case which was decided in America some years since is calculated to show that a fixed arbitrary principle, like that of the Roman law, with regard to the death of husband and wife, must operate unjustly.

There is no doubt that the rules which influence English Courts on these occasions are based on equitable principles. A right to property once acquired is not permitted to be taken away upon a mere *presumption*; the right may be averted by the production of satisfactory evidence, medical or general, but until this is brought forward, the property is considered to be vested in the holder and his heirs. Presumptions founded on age, sex, or the relative strength of persons are rather to be regarded as *assumptions* inadmissible, except when most strongly supported by direct evidence.

Under these circumstances it is scarcely necessary to refer to the rules which have been laid down by some medico-legal writers, in reference to the priority of death among persons who perish by a common cause, as by fire, starvation, suffocation, drowning, cold, or collisions on railways. M. Devergie asserts that a female will survive a male adult when both are equally exposed to suffocation from carbonic acid; but a sufficient number of cases have not been observed to allow a fair medical inference on this point to be drawn; and very strong evidence would be required by an English judge to satisfy him that such an opinion was universally correct. As little can it be presumed that the young perish from suffocation before the old. These events are commonly treated as involving circumstances which are from their nature unascertainable; and they are therefore dealt with according to fixed legal, and not according to variable medical rules. There are probably no two cases of death from a common cause, in which all the circumstances will be alike; hence any general medical rule for assigning survivorship to one in preference to another, is inapplicable.

The case of *Underwood* v. *Wing*, involving a singular question of survivorship, was brought before the Rolls Court in July 1854. The opinions of Sir James Paget, the late Dr. Brinton, and myself, were requested on one of the questions at issue in this case, namely, whether, under an apparently simultaneous death from drowning as a result of shipwreck, the husband survived the wife or the wife the husband for even the shortest conceivable period of time. The following is an outline of the facts:—

'Mr. Underwood, a man æt. 43, and his wife æt. 40, had a daughter aged 18 and two sons of the respective ages of 15 and 13. The husband and wife were entitled to some small property, and being about to go to Australia, with their children, they respectively made their wills, the one giving to the other absolutely, the whole of their respective properties, and by each such will, they declared, that if the one to whom the same was given should *die in the lifetime of the donor*, the property should go and be divided among

their three children on their attaining majority; and that in case all their said children died under 21, they then directed that their property should go to their mutual friend, Mr. Wing, the defendant. Mr. Underwood was a tall powerful man with a full and broad chest, of the height of six feet and one inch; he weighed about twelve stone. His wife was a little woman of rather delicate habit, not exceeding five feet two inches in height, and weighing between eight and nine stone. They, together with their three children, sailed from London on October 13, 1853, by the ship 'Dalhousie,' and were wrecked off Beachy Head. Every person on board, with the exception of one seaman named Read, perished. Read stated that the ship foundered early on the morning of the 19th October, and went over on her beam-ends, and so floated for about twenty minutes, and then went down. Shortly after she so went over, Mr. Underwood, Mrs. Underwood, and their two boys were pulled out of the cabin window on to the side of the ship, Mr. Underwood having nothing on but his coat and trousers, Mrs. Underwood and the two boys being in their night-clothes. In the excitement of the moment, Mr. Underwood clasped his wife in his arms, and the boys clung to their mother: while in that position a heavy wave swept the four from the side of the ship into the sea, and as the sailor says, he never saw them afterwards, so he presumes they all went down together. The daughter was seen alive on the deck shortly afterwards, and she was lashed by him to a spar and set adrift on the sea. It further appeared from the evidence of Read, the only witness of the facts, that he saw the daughter alive in the sea, after the spar of timber had been cast adrift, and long after the father, mother, and sons had been swept overboard. Upon the question of survivorship, as to Mr. or Mrs. Underwood or of the two sons, a great body of evidence was adduced. Mr. Wooton and Mr. Hancock were examined, and they deposed that in their opinion the deaths of all the four, *i.e.* the father and mother and two sons, had been *simultaneous*. Other surgeons had been examined, who gave it as their opinion that Underwood, who was a strong man, and a good swimmer, must have survived his wife and children in the waves, and that a man accustomed to swim would have it in his power to preserve his breath longer than a woman or boys so young as his two sons. Others thought that whilst the woman and her sons died of asphyxia, the man, being strong and muscular, might have died before them from an attack of apoplexy.

The Master of the Rolls held that the weight of evidence as to Mr. and Mrs. Underwood and the sons, was that they had been swept off the wreck at one and the same moment, and had perished simultaneously. The evidence of Read, who conducted himself with great courage and humanity upon the occasion, appeared to be worthy of credence, and he decided that as respected these four individuals, there was no survivorship. With respect to the daughter Catherine it was established, beyond a doubt, as he thought, that she had been seen alive after her parents and brothers had perished in the raging sea. Then in her instance there was no doubt she survived them, and the result must be that the property could not vest in the defendant, but in the plaintiff, who was the next of kin of Catherine Underwood. The event upon which the defendant was to take never arose, and the claim of the plaintiff, as next of kin, was fully established.

The case was carried by appeal to the Lord Chancellor's Court, and subsequently to the House of Lords. The point referred for our consideration, was not whether the daughter survived the parents (as all the children died under the age of 21), but whether, upon ordinary physiological principles, the husband must not have survived the wife, or the wife the husband, and in either case the defendant would have a well-founded claim to the property. The

plaintiff, Underwood, a lady, and the next of kin of the husband, claimed the property on the ground that neither survived the other, and that both must have died together.

Our opinions were to the effect that the great strength of the husband, with the knowledge that he was a good swimmer, would justify a medical inference that he might probably have survived his wife, although only for a short period. Further, we were of opinion that, considering the nature of death by asphyxia, even if husband and wife were submerged at the same instant of time, there was no proof that they had really died at the same instant. Taking death to consist in the entire and permanent stoppage of the action of the heart, it could not be inferred of these two persons, differing as they did in age, sex, and strength, that the heart in each ceased to pulsate at the same fractional part of a second of time. Unless this physiological improbability, if not impossibility, were admitted, then it followed either that the husband survived the wife, or the wife the husband, and in either case, Wing, the defendant, would take the property under the will of either. The case was heard by the Lord Chancellor (Cranworth), and two of the Common Law Judges; and in February 1855, the Lord Chancellor delivered the following judgment:—

The Master of the Rolls held, that as the only title of the defendant rested upon a survivorship, it was incumbent upon him to make out his case. No such case had been made out, and therefore the plaintiff, as representing the next of kin, was entitled to the property. His Honour was also reported to have stated it to be his opinion that the evidence had the legal effect of proving that Mr. and Mrs. Underwood died at the same time. In this latter opinion the judges differed from the Master of the Rolls, but agreed with him on the main point, that the defendant had failed to make out his title. His Lordship in now giving judgment said, that he had had a conversation with the Master of the Rolls since the opinion of the judges had been given, and his Honour had stated that he did not mean, by any expressions he might have used, to declare it to be his opinion that Mr. and Mrs. Underwood died at the same time. All that he meant was, that in the absence of any positive evidence on the point, the property must go in the same way as if they had actually expired at the same moment. Without doubt it was almost impossible that two human beings could die at the same moment. Time, like space, was divisible into infinitesimal parts, and one of them might be considered as having died a millionth part of a second before the other. The real point in the case, however, was that it was not known, and could not be ascertained, which of the two, the husband or the wife, was the survivor. The first and simple view of the case was, that a lady disposed of her property by will to a particular person in the event of her husband dying in her lifetime. Now, in the absence of any proof that the contingency upon which the gift depended had taken place, the property must be considered as undisposed of, and the appeal would, as a matter of course, have been dismissed. An ingenious argument had, however, been made use of for the defendant, to the effect that, as there was a manifest intention in the will of Mrs. Underwood to dispose of her property in the event of her surviving her husband, the onus of proving that she did not survive him lay upon the parties disputing the disposition, and a great number of cases had been cited in support of this view. His Lordship then analyzed the cases, and stated it to be his opinion that they did not affect the present case, and he therefore came to the conclusion that the decision of the Master of the Rolls was correct. The appeal must be dismissed, but, under the peculiar circumstances of the case, without costs. Litigation did not stop here. The case was carried by appeal to the House of Lords, and in February 1860, six

years after the commencement of the suit, a final judgment was given confirming the decree of the Master of the Rolls and of Lord Cranworth, the then Lord Chancellor (Campbell) dissenting from this decision.

The remarks made by Mr. Best, although published some years before the occurrence of this singular case, embrace the whole subject by anticipation. He says, 'The true conclusion seems to be, that the law of England recognizes no *artificial* presumption in cases of this nature; but leaves the real or supposed superior strength of the parties perishing by a common calamity to its natural weight, as a *circumstance* proper to be taken into consideration by a jury or judge called on to determine the question of survivorship, but which *circumstance* standing alone, is insufficient to shift the burden of proof. If, therefore, the party who, by laying claim to property on the ground of the survivorship of one individual over another, takes upon himself the onus of proving *that* survivorship, has no further evidence than the assumption that, from age or sex, one party struggled longer against their common death than his companion, it seems that no decree would have been made in favour of the claim. But, on the other hand, it is not quite correct to say that the law *presumes* both to have perished at the same moment. This would be to establish an artificial presumption against manifest probability, although the practical consequence is in many cases the same; because if the party on whom the onus lies, cannot show affirmatively which died first, the question will necessarily be treated by the tribunal as a thing from its nature unascertainable, and that for all that appears to the contrary, both died at the same moment.' (Op. cit. 201.)

In reference to the case of *Underwood* v. *Wing*, it is obvious that the difficulty was created by the legal rule which threw the onus of proof on the claimant under the two wills. The case for the next of kin, who was not mentioned in the will, was that the husband and wife died at the same instant of time; but this was a physiological impossibility; and had the proof of this been thrown upon the plaintiff the case must have failed. The contention of the defendant was that the testator and testatrix could not have died at the same instant. This negative proposition could not, of course, be proved by direct evidence; it became simply a medical inference: but when the law declares that in the absence of evidence the property shall go in the same way as if the parties had actually expired at the same instant, *i. e.* as if they had died intestate, this is deciding such questions by a rule which is as arbirtary in its operation as that of the Code Napoleon. In *Underwood* v. *Wing* this rule of law practically affirmed that an event took place which was physiologically impossible, and upon that event the wills of husband and wife were set aside, and the property was handed to one whose name was intentionally excluded from the wills of both.

Hugh Swinton Ball, with his wife and adopted daughter, was lost on board the steamer 'Pulaske,' on the coast of America, on June 14, 1838. By his will Mr. Ball bequeathed his property to his wife, and a claim was made by her heirs on the ground that she had survived her husband. It seems that an explosion took place on board the steamer at eleven o'clock at night, and that husband and wife were at the time in different parts of the vessel, and thus separated from each other. Mr. Ball was not seen after the explosion, and, although he perished with many others, the precise time at which he died could not be determined. Mrs. Ball was seen after the explosion, rushing in a terrified manner about the deck, calling for her husband with the most piercing cries, but no reply was made. She was soon afterwards missed, the promenade deck to which she had retreated, having been submerged with herself and all who were on it. Chancellor Johnson, before whom the case was argued, said that it was a case to be decided by testimony, and as the right on the part of

Mrs. Ball was derivative, the burden was on the plaintiffs to prove that she was the survivor. The evidence regarding the non-appearance of Mr. Ball, when, had he been living, there was sufficient time for him to have shown himself with others on deck, and to have made an effort to join his wife, was considered by the Chancellor to be conclusive of his death at the time that the wife was seen and recognized by many who knew her. On these considerations he decided in favour of the plaintiffs, that the wife survived the husband, and, therefore, she succeeded to his estate. On appeal, in February 1840, this decision was confirmed. ('American Journal of Med. Sci.' July 1845.) This case is peculiar in the fact that the wife alone was seen living, and the nature of the accident was such as to render it probable that the husband had perished in the explosion. The counsel for the defendants ingeniously argued that as the death of the wife could be fixed, while that of the husband could not be fixed, it was fair to presume that she died first, but this argument failed to satisfy the Court. The plaintiffs were not required to prove when the husband really died: they established enough to render it probable that the wife was the survivor.

In July 1866 I was consulted in the following singular case:—A husband and wife quarrelled—the wife was a passionate woman; she suddenly ran across a lawn from the room in which they were sitting (the windows being open to the ground), and threw herself into a deep pond. Her husband followed immediately, and tried to save her from drowning. He either rushed or fell into the pond, and both were drowned. There was some evidence that the wife rose to the surface of the water after submersion, while the husband, it was stated, sank at once; but it was not made clear whether this re-appearance of the woman's body on the surface took place before or after the submersion of her husband. There was, therefore, a want of evidence to fix the priority of death on either. The suit was compromised.

The following cases, one of which was tried in England and the other in Scotland, arose out of the fate of the expedition to the Polar seas, undertaken by Sir John Franklin in the year 1845. The first is that of *Ommaney* v. *Stillwell*, Rolls Court, November, 1856. His Honour, in giving judgment, said that, although there was no point of law in it, it was one of great difficulty to decide upon, from the paucity and singular nature of the evidence adduced. The sole question in the case was whether a father or son, *i.e.* James or Edward Couch, died first. James, the father, died in January 1850. Of this there was no dispute. Edward, the son, went as mate on board Sir John Franklin's ship 'Erebus' on the Arctic Expedition in August 1845. The fact to be determined, was whether he was alive or dead, and, if dead, whether he predeceased his father or not. The only evidence on this point was to be found in the statement of Dr. Rae upon the probable fate of Franklin and his crew. Dr. Rae stated that he discovered the remains of a number of persons, supposed to be part of the 133 persons who joined in Sir John Franklin's expedition, and in 1854 he was informed by some Esquimaux that in April or May 1850, they saw a party of about thirty white men dragging a boat along, their ship being crushed up in the ice. Of these men, all were pulling or pushing at the boat but one, who appeared to be their leader, and was supposed by Dr. Rae to be Sir John Franklin. The Esquimaux further added that they saw the white men kill some birds which never visited that region before the month of May. Now, if this story of the Esquimaux could be relied upon, and it could in any way be shown that Edward Couch was among those persons whose remains Dr. Rae had discovered, there would be some kind of evidence, at any rate, to show that Edward Couch being alive in May 1850, survived his father, James Couch,

who died in January of that year. But there was nothing to show that Edward Couch was one of these persons, or anything whatever that could satisfy his mind that Edward Couch was among these then survivors of Sir John Franklin's crew. One of the Chief Clerks of the Court had, however, decided in favour of the son having survived the father, and, as it was just as impossible to say whether he did so survive or not, the Court, for the purpose of avoiding further litigation, so far as lay in its power, would confirm the Chief Clerk's report. Decree accordingly.

The second case came before the Court of Session in Scotland in 1857. The question at issue, was whether a naval officer who went out with the Franklin expedition was dead; and, if so, when must he be held to have died. The late *Adam Fairholme*, who died in May 1853, bequeathed his property to his nephew, James Walter Fairholme, lieutenant in the Royal Navy, who sailed from Northfleet, on board the 'Erebus,' for the North Seas, in May 1845, and had not since been heard of. George Fairholme, another nephew, had instituted an action to have it found, under the destination of a codicil, that he was entitled to the whole of the testator's personal estate, valued at 37,509*l*. This was opposed by other relatives, whose interests depended on whether or not James Walter survived his father. Proof by commission was taken with the view of legally establishing the questions raised in the case, and among those examined were Dr. Rae, Sir John Richardson, James Hargreave, chief factor in the service of the Hudson's Bay Company, Captain Penney, and others. Dr. Rae expressed his belief that those persons who were reported to have been seen in the spring of 1850, must have died in the May of that year, and these he believed to have been the last survivors of Franklin's party. James Hargreave thought that some of the party might have survived a single winter after they had been seen by the Esquimaux in 1850, but certainly not longer. Sir John Richardson said: 'That if any of the party reached the country where they were said to have been seen at the end of the winter of 1849-50, it was impossible for them to survive a single year with any means they could have at their disposal.' Captain Penney remarked: 'I do not think that any of the party could have survived 1852; they must either have perished from hunger, or the hostile attacks of the natives.' The Lord Ordinary (Mackenzie) reported the whole circumstances of the case to the Inner House, expressing his own opinion that there was thus strong presumptive evidence that Lieutenant Fairholme perished together with his companions some time prior to the end of 1852, and consequently that he predeceased his uncle, the testator, who died in May, 1853. His Lordship thought that under these circumstances, the pursuer, George Fairholme, was entitled to a decree in his favour, but qualified by this condition, that before payment, he should grant a bond with sufficient security to warrant the defender against all hazard from any claim to the money decerned for, by Lieutenant Fairholme or others in his right.

It would seem from an old case, *Broughton* v. *Randall* ('Croke's Elizabeth, 503), that provided there be some direct evidence, a very small amount of proof is required for survivorship. A father and son were seised as joint tenants and to the heirs of the son. Both father and son were hanged at the same time, in one cart; but because the son, as deposed to by some of the witnesses, survived, as appeared by the shaking of his legs and probably some other tokens, the wife was held entitled to her dower! (Best, op. cit. 194.)

There has been much ingenious discussion as to the survivorship of the mother or child, when both die during delivery, and nothing is known respecting their deaths. So far as I am aware this question has only occurred once in an old case, quoted by Dr. Beck; and then some local German Court

arbitrarily decided that the child survived the mother, basing its decision, according to Valentin, upon the grounds—1. that the mother was exhausted by the labour, and 2. that the infant would not have died, until deprived by the death of the mother of its nourishment. Now it is quite possible that the child might have died soon after its birth, and the mother have survived: at any rate the medical reasons for this view are just as good and just as forcible as those against it, and the only equitable mode of dealing with such cases, when a legal question of a right to property is dependent on the decision, is to treat them according to the principles followed in contested survivorship. Those who would benefit by the presumption that the child survived the mother should be required to adduce satisfactory proofs.

In some cases of presumed survivorship medical evidence may be of service —as where two persons are found dead from wounds affecting different parts, and these wounds are of different degrees of severity—or where two are found dead from any cause, and the body of the one is cold and rigid, while that of the other is warm and pliant: here we have medical facts which may serve to guide the Court, and enable it to come to a correct decision.

In *Greetham* v. *Milnes*, Rolls Court, November 1871, a question arose in reference to the survivorship of one *Hentig*, who was a member of Dr. Leichhardt's exploring party in Australia. They left Sydney for the interior in February 1848, with the intention of traversing the continent, and have not since been heard of. The testator died in February 1850, having bequeathed property to Hentig, who was his nephew. The heir at law of the testator claimed the property on the ground that Hentig died before the testator, who did not die until two years after Hentig was last seen and known to be alive. The heir at law of Hentig rested his claim on the absence of any proof of death at any time, and that the members of the expedition, including Hentig, might have survived at least two years in Central Australia. The Master of the Rolls said that the inference he must draw from the established facts was that Hentig died within a year of the exploring party leaving Sydney, and that the heir at law of the testator was therefore entitled to the property.

In a similar case (*Lewis's Trusts*, V.C. Malins, December 1870) the question was whether a legatee did or did not survive a testator so as to take a sum of 4000*l.* bequeathed to him under the will, which was dated in the year 1858. The testator died on February 20, 1860. The legatee, Thomas Lewis, went to Australia in the year 1858, and the last that was heard of him was by a letter written to a cousin dated January 3, 1859. Seven years having elapsed, he was presumed to be dead, but the question was whether he survived his father. The Vice-Chancellor said that the law in cases of this kind presumed the continuance of life until the expiration of seven years, when the contrary presumption of death arose. The case of *Phenes's trust* had, however, displaced that rule, and had laid down that in all cases it was incumbent on a person claiming property by reason of a person being alive at any particular time, to establish affirmatively that fact. It was manifest, therefore, that the representatives of the legatee, in order to claim their legacy, must show that the legatee survived the testator—the *onus probandi* being, according to the case cited, thrown upon them. They had not discharged, and could not discharge, that *onus*; therefore, as he was bound by the case in the Court of Appeal, he must hold that the legacy was never validly given, and that the residuary legatee took the fund as part of the estate.

In *Huelin* v. *Wilson*, before V.C. Malins, July 1871, the question was whether the deceased Huelin survived his housekeeper or not. He had made a bequest in favour of this woman. In May 1870, Huelin and his housekeeper were found dead in a house at Brompton. They had obviously been

murdered. The body of Huelin was found buried, while that of the woman was packed in a box, and had marks about it of more recent death. The medical and circumstantial evidence left no doubt that the murder of the woman had not taken place until after the death of Huelin, the testator, and the Vice-Chancellor decided accordingly that she survived to take the bequest. In April 1872 a case came before the Probate Court which involved the question of survivorship of husband or wife (*Re J. R. Jefferies*). It appeared in evidence that they had died on the same day and within a short time of each other, but there was some evidence that about an interval of two hours elapsed between the deaths of husband and wife, the husband being at the time an inmate of a lunatic asylum. The administration of the estate was claimed by the relatives of both, but as there was proof that the husband had really survived although but a short time, the decision was made in favour of the relatives of the husband.

In a case, in which husband and wife were found dead, both severely wounded and the bodies burnt, Dr. Ollivier remarked that the burns on the body of the wife had the characters of those which are produced during life, while those on the body of the husband were exactly like burns which are caused on a dead body. He thence inferred, as they were exposed to the same cause of burning, that the wife survived the husband; for he considered that all signs of vitality must have ceased in him before the fire could have reached his body.

POISONING.

CHAPTER 10.

DEFINITION OF THE TERM POISON—DEADLY POISONS—MECHANICAL IRRITANTS—INFLUENCE OF HABIT AND IDIOSYNCRASY—CLASSIFICATION—SPECIAL CHARACTERS OF IRRITANT CORROSIVE AND NEUROTIC POISONS.

Definition.—A POISON is commonly defined to be a substance, which, when administered or taken *in small quantity*, is capable of acting deleteriously on the body: in popular language, this term is applied only to those substances which destroy life in small doses. This popular view of the nature of a poison is too restricted for the purposes of medical jurisprudence. It would obviously exclude numerous compounds, the poisonous properties of which cannot be disputed—as, for example, the salts of copper, tin, zinc, lead, and antimony; these, generally speaking, act as poisons only when administered in *large* doses. Some substances, such as nitre, have not been observed to have a noxious action except when taken in large quantity, while arsenic acts as a poison in a small dose; but in a medico-legal view, whether a man dies from the effects of an ounce of nitre, or two grains of arsenic, the responsibility of the person who criminally administers the substance, is the same. Each may be regarded as a poison, differing from the other only in its degree of activity, and in its mode of operation. The result is the same: death is caused by the substance taken, and the *quantity* required to destroy life, even if it could be always accurately determined, cannot enable us to distinguish a poisonous from a non-poisonous substance. If, then, a medical witness be asked, 'What is a poison?' he must beware of adopting this popular definition, or of confining the term poison to a substance which is capable of operating as such in a small dose taken at once.

In legal medicine, it is difficult to give such a definition of a poison as shall be entirely free from objection. Perhaps the most comprehensive which can be suggested is this:—'A poison is a substance which, when absorbed into the blood, is capable of seriously affecting health or of destroying life.' There are various channels by which poisons enter the blood: some are in the form of gases or vapours: these operate rapidly through the lungs; others are liquid or solid, and these may reach the blood either through the skin or through a wound: but more commonly through the lining membrane of the stomach or bowels, as when they are taken or administered in the ordinary manner. The latter chiefly give rise to medico-legal investigations. Some substances act as poisons, by any one of these channels: thus arsenic is a poison whether it enters the blood through the lungs, the skin, or the stomach and bowels: but such poisons as those of the viper, of rabies, and of glanders, appear to affect the body only through a wound in the skin. When introduced into the stomach, these animal poisons have been found to be inert. In adopting the above definition of a poison in a medical sense, it is proper to remark that there are some substances which

are regarded as poisons, although absorption into the blood does not appear to be necessary to their action. The mineral acids and alkalies belong to this class of bodies. They are corrosive poisons: they operate injuriously by causing the destruction of living parts; and whether applied to the skin, the stomach, or (in the form of vapour) to the air-cells of the lungs, they destroy life by the local changes to which they give rise, and the inflammation which is a consequence of their action.

It is not easy to define the boundary between a medicine and a poison. It is usually considered that a medicine in a large dose is a poison, and a poison in a small dose is a medicine; but a medicine such as tartarized antimony may be easily converted into a poison, by giving it in small (medicinal) doses at short intervals, either under states of the body not adapted to receive it, or in cases in which it exerts an injuriously depressing effect. Some deaths have been lately occasioned by this wilful misuse of antimony in doses which might be described as *medicinal*, although in the cases referred to, no other intention could have existed, in the secret administration of this substance, than that of destroying life. A person may die either from a large dose of a substance given at once, or from a number of small doses given at such intervals that the system cannot recover from the effects of one before another is administered. This remark applies to a great number of medicines which are not commonly included in a list of poisons.

In reference to the *medical* definition of a poison, it is necessary to observe that the law does not regard the manner in which the substance administered acts. If it be capable of destroying life or of injuring health, it is of little importance, so far as the responsibility of a prisoner is concerned, whether its action on the body is of a mechanical or chemical nature, or whether it operates fatally by absorption into the blood or not. Thus a substance which simply acts mechanically on the stomach or bowels may, if wilfully administered with intent to injure, involve a person in a criminal charge, as much as if he had administered arsenic or any of the ordinary poisons. It is, then, necessary that we should consider what the law strictly means by the act of poisoning. If the substance criminally administered destroys life, whatever may be its nature or mode of operation, the accused is tried on a charge of murder or manslaughter, and the duty of a medical witness consists in showing that the substance taken was the certain cause of death. If, however, death be not the consequence, then the accused may be tried for the attempt to murder by poison (24 & 25 Vict. c. 100, s. 11, Aug. 1861). The words of this statute are general, and embrace all kinds of substances, whether they are popularly or professionally regarded as poisons or not. Thus it is laid down that—

'Whosoever shall administer, or cause to be administered to or taken by any person, any poison, or *other destructive thing*, with intent to commit murder, shall be guilty of felony.'

Whether the administering be followed by any bodily injury or not, the act is still a felony, provided the *intent* has been to commit murder. The attempt to administer or the attempt to cause to be administered to, or to be taken by any person, any poison or *other destructive thing*, with the like intent, although no bodily injury be effected, is also a felony (s. 14). If any doubts formerly existed whether the *external* application of poisons, *e.g.* by wounds or ulcerated surfaces, would be included in the words 'administering or taking,' they are now entirely removed by the Criminal Law Consolidation Act (Aug. 1861). The 22nd section specially applies to such an offence, and the 15th section provides that 'Whosoever shall, by any means other than those specified in any of the preceding sections of this Act, attempt to commit murder, shall be guilty of felony.' Mr. Greaves justly remarks,

with regard to this important addition to the statute law, that 'the malicious may now rest satisfied that every attempt to murder which their perverted ingenuity may devise, or their fiendish malignity suggest, will fall within some clause of this Act, and may be visited with penal servitude for life.' ('Notes on Crim. Law Consolidation,' p. 49.) Under sect. 22 of this statute, in reference to attempted poisoning, some offences are comprised, which formerly escaped punishment: 'Whosoever shall unlawfully apply or administer to, or cause to be taken by, or attempt to apply or administer to, or attempt to cause to be administered to or taken by any person, any chloroform, laudanum, or other stupefying or overpowering drug, matter, or thing, with intent, in any of such cases, thereby to enable himself or any other person to commit, or with intent, &c. to assist any other person in committing any indictable offence, shall be guilty of felony.' A case under this section of the new statute was referred to me in September 1863. A medical gentleman was charged with 'attempting to cause to be administered' to an infant, a poisonous dose of laudanum. It was stated by a woman who nursed the child that the accused delivered to her two bottles containing a brown liquid, labelled 'one teaspoonful every three hours,' and directed her to give it to the child. None was given. Some months after the death of the child from natural causes, this charge was raised, and the bottles, still full of liquid, were produced as evidence against the accused. On analysis I found that the prescribed dose contained about five minims of laudanum, or nearly one half-grain of opium—a dose likely to prove fatal to an infant only a month old. Assuming the statement of the nurse who made the charge to be true, the only inference to be drawn from the description of such a dose for an infant by a medical man, would be that he intended to destroy the life of the child. The charge fell to the ground, as clear proof was given that the woman who made it was not to be believed on her oath, and that it had originated in a desire to extort money.

Poison is not always administered with intent to murder. On many occasions it has been mixed with food, and thus administered with a view to injure or annoy a person. Cantharides have been thus frequently given, and in one instance (Nov. 1859) eight members of a family suffered from severe symptoms of poisoning by reason of the wanton administration of this drug. In April 1860, several members of a family suffered from severe sickness, as a result of tobacco having been put into water contained in a teakettle; and tartar emetic has been in some cases dissolved in beer or other liquids as a mere frolic, without any proved or probable intention on the part of the offender to destroy life. The case of *M'Mullen* (Liverpool Autumn Assizes, 1856), revealed an extensive system of poisoning in the northern counties, in which tartar emetic was the substance employed. This drug, mixed with cream of tartar, was openly sold by druggists under the name of 'quietness powders,' and the evidence established that women gave these powders to their husbands with a view to cure them of habits of drunkenness. Hitherto, when the intent to murder has not been proved, the offender has escaped, although great bodily injury may have been done by his wanton or malicious act. Sections 23, 24, and 25 of the Consolidation Act, c. 100, provide for this omission:—

'23. Whosoever shall unlawfully and maliciously administer to, or cause to be administered to or taken by any other person, any poison or *other destructive* or *noxious thing*, so as thereby to endanger the life of such person, or so as thereby to inflict upon such person any grievous bodily harm, shall be guilty of felony.'

'24. Whosoever shall unlawfully and maliciously administer to, or cause to be administered to or taken by any other person, any poison or other

destructive or noxious thing, with intent to injure, aggrieve, or annoy such person, shall be guilty of a misdemeanour.'

'25. If, upon the trial of any person charged with the felony above mentioned, the jury shall not be satisfied that such person is guilty thereof, but shall be satisfied that he is guilty of the misdemeanour above mentioned, then and in every such case the jury may acquit the accused of such felony, and find him guilty of such misdemeanour.'

It will be perceived that the words of the statute leave the question 'What is a poison?' to depend upon the medical evidence adduced: and in order to include all substances of an injurious nature, although they may not be strictly speaking poisons, the words '*destructive* or *noxious thing*' are employed. Hence, on these occasions, a medical witness must be prepared to prove that the substance was either a poison or a destructive or noxious thing. In a trial which took place at the Essex Lent Assizes, 1850 (*Reg.* v. *Hayward*), a woman was charged with administering *white precipitate* to her husband, with intent to kill. She was acquitted on the ground that there was no evidence to show that white precipitate was either a poison or a destructive thing! It is, however, placed beyond doubt that this substanee is not only capable of producing all the effects of an irritant poison, but of destroying human life; hence this acquittal was based on a pure mistake. *White hellebore*, *Lobelia inflata*, and *Oil of turpentine*, have been erroneously pronounced not to be poisons under similar circumstances; in fact, when this question is raised, unless the medical evidence received by a Court be very closely investigated, great mistakes may arise, owing perhaps to want of experience or want of reflection on the part of those to whom the question is put.

The quantity of a poisonous substance found in an article of food, or in a dead body, does not affect the culpability of a person indicted for administering it. In the case of *Hartley* (C. C. C. May 12, 1850), in which an attempt was made to administer sulphuric acid mixed with coffee, Cresswell, J. stated—if poison be administered with intent to murder, it is not necessary there should be enough in the article administered to cause death. If any poison be there, and the intent be proved, the crime of attempting to administer poison is complete. Erle, J. ruled to the same effect, in reference to the discovery of a small quantity of arsenic in a dead body, in *Reg.* v. *Bacon* (Lincoln Summer Assizes, 1857). In *Reg.* v. *Southgate* (Chelmsford Lent Assizes), Parke, B. said, in reply to an objection taken, it was quite immaterial to define or prove in what vehicle a poison was given, or whether it was administered in a solid or liquid state.

This question, 'What is a poison?' may present itself under another aspect. In *The Queen* v. *Cluderay* (Exchequer Chamber, January 19, 1849), the prisoner was indicted for administering poison with intent to murder. He was proved to have administered to a child nine weeks old, two berries in the husk, of *Cocculus Indicus*, and the berries passed through the body of the child without doing any injury. It was submitted for the prisoner, that being in the husk, they could not be considered a poison. The point was reserved by Williams, J., who tried the case at York. It was now contended for the prisoner, that although the kernel of this nut was poisonous, still having been given in the husk, which was hard of digestion, it could not be considered an administering of poison within the statute. The Chief Justice said the Court was of opinion that, when a man administered something that was poison with intent to murder, but in such a way that it did not act, he was guilty. Conviction affirmed. This is the only reasonable view to take of such a frivolous objection. The seed contains the poison, but the husk is inert: nevertheless the berry as a whole must be regarded as a poison.

Deadly Poison.—The term 'deadly' can be applied with propriety only to those poisons which may prove speedily fatal in small doses, *e. g.* prussic acid, arsenic, strychnia, aconitina, and nicotina; and although it has been used in indictments in reference to such substances as blue or green vitriol, and common sal volatile, this has arisen from an unnecessarily strict adherence to old legal forms. In a case (*Reg.* v. *Haydon*, Somerset Spring Assizes, 1845), in which 'spirit of hartshorn' was thus described as a 'deadly poison,' and an objection was taken to the validity of the indictment, the learned judge (Erle, J.) held that the word *deadly* was not essential; it was mere surplusage ('Law Times,' April 12, 1845).

Mechanical Irritants.—The substance administered may not be a poison in the medical signification of the term, and it may not be popularly considered as such; yet, when taken, it may be noxious to health or destructive to life. We have examples of substances of this description in iron-filings, powdered glass, sponge, pins and needles, and such like bodies, which have been administered with the wilful design of injuring, and have on various occasions given rise to criminal charges. In cases of this kind, the legal guilt of a prisoner may often depend on the meaning assigned by a medical witness to the words *destructive thing*. Thus, to take an example, liquid mercury might be poured down the throat of an infant, with the deliberate intention to destroy it. A question of a purely medical nature will then arise, whether mercury be a 'destructive thing' or not; and the conviction of a prisoner will probably depend on the answer. Should a difference of opinion exist, an occurrence by no means unusual in medical evidence, the prisoner will, according to the humane principle of our law, receive the benefit of the doubt. The injuries produced on cattle by mechanical irritants have occasionally given rise to civil actions for damages. In *Newton* v. *Woodhurst* (Nottingham Autumn Assizes, 1871), the plaintiff claimed damages for the loss of three horses, by reason of their having been killed by rice-meal supplied by the defendants. The horses were fed on the meal: they were taken ill, and died. In the stomachs of each a large quantity of stuff was found containing five per cent. of sand. This had acted as a mechanical irritant, and had caused death. From the evidence it appeared that the so-called meal consisted of the dust and refuse from the sweepings of the floors. The jury were discharged without a verdict.

Influence of Habit on Poisons.—Habit, it is well known, diminishes the effect of certain poisons: thus it is that opium, when frequently taken by a person, loses its effect for a time, and requires to be administered in a much larger dose. Indeed, confirmed opium-eaters have been enabled to take at once a quantity of the drug which would have infallibly killed them, had they commenced with it in the first instance. Even infants and children, who are well known to be especially susceptible of the effects of opium, and are liable to be poisoned by small doses, may, by the influence of habit, be brought to take the drug in very large quantities. This is well illustrated by a statement made by the late Mr. Grainger, in the 'Report of the Children's Employment Commission.' It appears that the system of drugging children with opium in the factory districts commences soon after birth; and the dose is gradually increased until the child can take from fifteen to twenty drops of laudanum at once! This has the effect of throwing it into a lethargic stupor. Healthy children of the same age would be killed by a dose of five drops. The same influence of habit is manifested more or less in the use of tobacco, alcohol, ether, chloroform, morphia, strychnia, and other alkaloids. Sir R. Christison has remarked that this influence is chiefly confined to poisons derived from the organic kingdom: it is so limited with regard to mineral substances that it can scarcely be said to exist. The stories related of the

arsenic-eaters of Styria, and the corrosive sublimate-eaters of Turkey, are therefore to be received with great distrust. There is no satisfactory evidence that any human being has ever accustomed himself, by habit, to take these substances daily in doses that would prove poisonous to the generality of adults. M. Flandin states that he gave to dogs doses of arsenic in powder, commencing with 1-16th of a grain mixed with their food; and that in nine months, by progressive increase, they bore doses of upwards of fifteen grains of arsenic in powder in twenty-four hours, without becoming affected in appetite or health! ('Traité des Poisons,' 1, 737.) This is contrary to all experience in the medicinal use of arsenic in the human subject; for, as it will be seen hereafter, a slight increase of a medicinal dose has often been attended with such alarming symptoms, as to render a discontinuance of the medicine absolutely necessary to the safety of the person. The most singular part of M. Flandin's statement is, that the arsenic thus given, appears to have remained in the body of the animal without causing injury! Thus he states that he examined the urine of the animals while living, without detecting appreciable traces of arsenic. The arsenic must, however, have undergone some rapid and extraordinary metamorphosis, for, in killing the animals on the third day, after the last dose had been given, none could be detected in their viscera, their flesh, or their bones! Such a state of things is inconsistent with all that has been hitherto acquired by experience regarding the operation of this or other poisons. Further observations are required before it can be admitted that dogs by habit can swallow fifteen grains of arsenic at a dose without the production of symptoms of poisoning, and at the same time no trace of the poison be detected in the urine while the animal is living, or in the body three days after its death.

In reference to the Styrian practice of arsenic-eating, Dr. Roscoe has published a case in which, according to information supplied to him, a Styrian took in one day four and a half grains of white arsenic, and on the day following five and a half grains, crushing the mineral between his teeth and swallowing it. The day after he had swallowed the second dose, the man left the place in his usual health, and there is no further record of him. Dr. Knapp states that a man once took in his presence seven and a half grains of arsenic; it did not produce the slightest visible influence on his feelings. A portion of his urine passed on the same and the following day was examined by Marsh's process, and it was found to contain arsenic. ('Ed. Monthly Jour.' Jan. 1869, p. 669.) Other cases of a similar kind are related by Dr. C. Maclagan, in the same journal, Sept. 1864, p. 200. He saw one man swallow between four and five grains of arsenic in powder. This man had been accustomed to take it for a year, beginning with small doses; he did not suffer from any bad effects. A man, æt. 46, swallowed six grains of arsenic, washing it down with cold water. Arsenic was detected in the urine about an hour after the poison was swallowed; but as they were habitual arsenic-eaters, it is probable that the eliminated arsenic may have been of longer date.

Such cases as these admit of no explanation on ordinary English experience. That they are of an exceptional nature is proved by a case communicated to the 'Ed. Med. Journal,' 1864, p. 116, by Dr. Parkes, of Halifax. A man who had carried on the practice of arsenic-eating for three or four years suffered from all the symptoms of arsenical cachexia. He sank under this practice, and after death the usual appearances of chronic poisoning by this substance were found. A chemical analysis showed only slight traces of arsenic in the liver, and none in the stomach. *Habit* appears to have so little influence on this substance under the most careful medicinal use in this country, that I believe no medical practitioner has ever succeeded in causing a patient to take two grains at a dose (the smallest quantity yet known

to have destroyed life). Mr. Hunt, who has perhaps more extensively employed arsenic than other practitioners, fixes the maximum dose at one grain (two drachms of Fowler's solution). In Dr. Roscoe's informant's case, the man swallowed, in two doses, on two successive days, a quantity of arsenic equivalent to *two ounces* and *a half* of Fowler's mineral solution! *i.e.* sufficient to kill five adults. There is, however, a difficulty in assigning the alleged tolerance of this poison merely *to habit.* Dr. Roscoe quotes from Dr. Schäfer, 'a most important case of the administration of no less than 555 grains of arsenic to a horse in twenty-three days, without any evil effects being produced.' It is not stated that the animal began to take arsenic in early life; and habit could have had but little influence in three weeks the large quantity here given, even admitting that small doses were given at first, and that these were gradually increased. As no evil effects were produced, the only inference is, that by some speciality of organization, arsenic was not a poison to this animal. There are on record several instances of human beings having recovered from very large doses.

Dr. Roscoe's pamphlet satisfactorily shows that symptoms of acute poisoning, gastro-enteritis and death, are sooner or later the results of the adoption of this dangerous practice in Styria. It would be difficult to persuade an English peasant, however ill-educated, that he could safely put into his daily food a substance which he used for destroying vermin,—or an English woman, that she could safely take, to improve her personal attractions, a mineral which pregnant women were in the habit of using to procure abortion (p. 7). It is a strange and inexplicable circumstance, if this practice exists, that the medico-legal writers of Germany have not dealt with the question by a proper investigation of the alleged facts. In the elaborate work of Casper ('Practisches Handbuch der gerichtlichen Medicin,' 1857–8), although the subject of arsenical poisoning is very fully treated, there is no reference to the existence of a class of toxophagists in Styria. The recent works of Böcker, Bock, and Otto, as well as the German Quarterly Journals devoted to Legal Medicine, are equally silent on the alleged practice. (See a paper by M. Kopp, 'Moniteur Scientifique,' Mars 1861, liv. 101, p. 106.)

The alleged impunity of the Styrians in the habitual use of arsenic, may be occasionally quoted to explain the detection of the poison in a dead body or a motive for its purchase; but no scientific witness who has seen anything of the operation of arsenic in this country can allow these statements to influence his opinion of its effects on human beings. Those who profess to believe in this practice, would be among the last to make a trial of it either on their own persons or among their friends.

The only form in which I have known the question of habit to be seriously raised in medical jurisprudence is this: whether, while the more prominent effects of a poison are thereby diminished, the insidious or latent effects on the constitution are at the same time counteracted. The answer is of some importance in relation to the subject of life-insurance:—for the concealment of the practice of opium-eating by a person whose life was insured, has already given rise to an action, in which medical evidence on this subject was rendered necessary. As a general principle, we must admit that habit cannot altogether counteract the insidious effects of poisons; and that the practice of taking them is liable to give rise to disease or to impair health. (See case by Dr. Parkes on the preceding page.)

Influence of Idiosyncrasy.—Idiosyncrasy differs from habit:—it does not, like habit, diminish the effect of a poison: for it is not commonly found that any particular state of body is a safeguard against the effects of these powerful agents. Some constitutions are observed to be much more affected than others by certain poisons: thus opium, arsenic, mercury, lead, and antimony

are substances of this description, and this difference in their effect is ascribed to idiosyncrasy. Sir R. Christison mentions a remarkable instance, in which a gentleman unaccustomed to the use of opium, took nearly an ounce of laudanum without any effect. ('On Poisons,' 33.) This form of idiosyncrasy is very rare. Certain substances generally reputed harmless, and, indeed, used as articles of food, are observed to affect some persons like poisons. This is the case with pork, certain kinds of shell-fish, and edible mushrooms. There may be nothing poisonous in the food itself; but it acts as a poison in particular constitutions—whether from its being in these cases a poison *per se*, or rendered so by changes during the process of digestion, it is difficult to say. The subject of idiosyncrasy is of importance in a medico-legal view when symptoms resembling those of poisoning, follow a meal consisting of a particular kind of food. In such a case, without a knowledge of this peculiar condition, we might hastily attribute to poison, effects which were really due to another cause. It would appear that in some instances idiosyncrasy may be acquired—*i. e.* a person who, at one period of his life, had been in the habit of partaking of a particular kind of food without injury, may find at another period that it will disagree with him. When pork has been disused as an article of diet for many years, it cannot always be resumed with impunity. In cases in which the powers of life have become enfeebled by age, the susceptibility of the system to poisons is increased; thus aged persons may be killed by comparatively small doses of arsenic and opium. Cases of acquired idiosyncrasy are very rare; it appears to be, if we may so apply the term, a congenital condition. There are, however, certain diseases which appear to confer a power of supporting large and even poisonous doses of some substances. Very large doses of opium have been taken without producing dangerous symptoms by persons labouring under tetanus and hydrophobia. This condition is called *tolerance*. It has been also witnessed in diseases of the lungs in reference to the use of antimonial medicines.

CLASSIFICATION OF POISONS.—Poisons have been divided into three classes, according to their mode of action on the system; namely, IRRITANTS, NARCOTICS, and NARCOTICO-IRRITANTS. This classification is a modification of that originally proposed by Orfila. The Narcotics and Narcotico-irritants may, however, be regarded as constituting one large class, the NEUROTICS, as their special action is to affect directly one or more parts of the nervous system. The Neurotic poisons admit of a subdivision into Cerebral, Spinal, and Cerebro-spinal, according to whether the poisonous substance affects directly the brain, the spinal marrow, or both of these organs.

IRRITANTS.—The irritants are possessed of these common characters. When taken in ordinary doses, they occasion speedily violent vomiting and purging. The symptoms are either accompanied or followed by pain in the stomach and bowels. The peculiar effects of the poison are manifested chiefly on these organs, which, as their name implies, they irritate and inflame. Many substances belonging to this class of poisons possess corrosive properties; such as the strong mineral acids, caustic alkalies, bromine, corrosive sublimate, and others. These, in the act of swallowing, are commonly accompanied by an acrid or burning taste, extending from the mouth down the gullet to the stomach. Some irritants do not possess any corrosive action—of which we have examples in arsenic, the poisonous salts of barium, carbonate of lead, and cantharides; these are often called pure irritants. They exert no destructive chemical action on the tissues with which they come in contact; they simply irritate and inflame them.

Difference between corrosive and irritant Poisons.—As a result of the action

of *corrosive* poisons, symptoms are commonly manifested immediately, because mere contact produces the destruction of a part. In the action of the purely *irritant* poisons, the symptoms are generally more slowly manifested, rarely showing themselves until at least half an hour has elapsed from the time of swallowing the substance. Of course, there are exceptions to this remark; for sometimes irritants act speedily, though rarely with the rapidity of corrosive poisons. It is important in a practical view, to ascertain whether, in an unknown case, the poison which a person requiring immediate treatment may have swallowed, is irritant or corrosive. This may be commonly determined by a knowledge of the time at which the symptoms appeared after the suspected substance was taken. We may thus often easily distinguish between a case of poisoning from arsenic and one from corrosive sublimate. There is also another point which may be noticed. As the corrosive substance exerts a decidedly chemical action, an examination of the mouth and throat may enable us in some cases to solve the question.

It has already been stated that there are many irritant poisons which have no corrosive properties, but every corrosive may act as an irritant. Thus the action of corrosive sublimate is that of an irritant poison, as, while it destroys some parts of the coats of the stomach and intestines, it irritates and inflames others. So again most corrosive poisons may lose their corrosive properties by dilution with water, and then they act simply as irritants. This is the case with the mineral acids, and bromine. In some instances, it is not easy to say whether an irritant poison possesses corrosive properties or not. Thus oxalic acid acts immediately, and blanches and softens the mucous membrane of the mouth and throat, but I have not met with any decided marks of chemical corrosion produced by it in the stomach or viscera. Irritant poisons, for the most part, belong to the mineral kingdom; and they may be divided into the *Non-metallic* and *Metallic* irritants. There are a few derived from the animal and vegetable kingdom; but these, if we except cantharides, are not often employed criminally. Some of the gases likewise belong to the class of irritant poisons.

NEUROTICS.—Neurotic poisons act upon the nervous system, and their operation is confined chiefly to the brain and spinal marrow. Either immediately or some time after the poison has been swallowed, the patient suffers from head-ache, giddiness, numbness, paralysis, stupor, and in some instances convulsions. They have not an acrid burning taste like the corrosive irritants; and they rarely give rise to vomiting or purging. When these symptoms follow the ingestion of the poison into the stomach, the effect may be generally ascribed either to the form or quantity in which it has been taken, and the mechanical effect on the stomach thereby produced, or to the poison being combined with some irritating substance, such as alcohol. The pure *narcotics*, or *Cerebral poisons*, are not found to irritate or inflame the stomach and bowels.

Notwithstanding the well-defined boundary thus apparently existing between these two classes of poisons, it must not be supposed that the substances arranged in each class always act in the manner indicated. Some irritants have been observed to affect the brain or the spinal marrow, and this may be either a primary or a secondary consequence of their action. Arsenic and oxalic acid, although classed as irritants, have in some instances given rise to symptoms closely resembling those of narcotic poisoning; namely, coma, paralysis, and tetanic convulsions. In a case of poisoning with arsenic, which occurred to Dr. Morehead, of Bombay, the symptoms of narcotism were so strongly marked, that it was believed at first the man had taken a narcotic. ('Med. Gaz.' vol. 43, p. 1055.) I have met with a case of poisoning by arsenic in which there was paralysis of the limbs, with an entire absence of purging, during the eight days that the deceased survived. On the other

hand, in a case of poisoning by a large dose of opium, there was an absence of the usual symptoms of cerebral disturbance, and the presence of others resembling those of irritant poisoning—namely, pain and vomiting. Thus, then, we must not allow ourselves to be misled by the idea that the symptoms are always clearly indicative of the kind of poison taken. The narcotic or cerebral poisons are few in number, and belong to the vegetable kingdom. Some of the poisonous gases and vapours possess a narcotic action.

Narcotico-irritants. (*Spinal and Cerebro-spinal Poisons.*)—Poisons belonging to this class have, as the name implies, a compound action. They are chiefly derived from the vegetable kingdom. At variable periods after they have been swallowed, they give rise to vomiting and purging, like irritants; and sooner or later produce stupor, coma, paralysis and convulsions, owing to their effects on the brain and spinal marrow. In the state of vegetables, as leaves, seeds, or roots, they possess the property, like irritants, of irritating and inflaming the stomach and bowels. As familiar examples we may point to nux vomica, monkshood, hemlock, and poisonous mushrooms. This class of poisons is very numerous, embracing a large variety of well-known vegetable substances; but they rarely form a subject of difficulty to a medical practitioner. The fact of the symptoms occurring after a meal at which some suspicious vegetables may have been eaten, coupled with the nature of the symptoms themselves, will commonly indicate the class to which the poison belongs. Some of these poisons have a hot acrid taste; others, like aconite or monkshood, produce a sense of numbness or tingling, while others again have an intensely bitter taste, as nux vomica, strychnia, veratria and picrotoxia. Strychnia may be regarded as a pure spinal poison.

CHAPTER 11.

EVIDENCE OF POISONING IN THE LIVING SUBJECT—ACTION OF POISONS INCREASED OR DIMINISHED BY DISEASE—SYMPTOMS CONNECTED WITH FOOD OR MEDICINE—SEVERAL PERSONS ATTACKED SIMULTANEOUSLY—EVIDENCE FROM THE DETECTION OF POISON IN THE FOOD.

We now proceed to consider the evidence of poisoning in the *living* subject. To the practitioner the diagnosis of a case of poisoning is of great importance, as by mistaking the symptoms produced by a poison for those arising from natural disease, he may omit to employ the remedial measures which have been found efficacious in counteracting its effects, and thus lead to the certain death of the patient. To a medical jurist a correct knowledge of the symptoms furnishes the chief evidence of poisoning, in those cases in which persons are charged with the malicious and unlawful administration of poison. The symptoms produced during life, constitute also an important part of the evidence in those instances in which a poison proves fatal. At present, however, we will suppose the case to be, that poison has been taken and the patient survives. Most toxicological writers have laid down certain characters whereby it is said symptoms of poisoning may be distinguished from those of disease.

1. *In poisoning, the symptoms appear suddenly, while the person is in health.*—It is the common character of most poisons, when taken in the large doses in which they are usually administered with criminal intent, to produce serious symptoms, either immediately or within a very short period after they have been swallowed. Their operation, under such circumstances, cannot be suspended, and then manifest itself after an indefinite interval; although this

was formerly a matter of universal belief, and gave rise to many absurd accounts of what was termed *slow* poisoning.

The symptoms of poisoning by nicotina, prussic acid, oxalic acid, or the salts of strychnia, appear immediately, or generally within a very few minutes after the poison has been swallowed. In an exceptional case, in which the dose of prussic acid was small, and insufficient to produce death, the poison was supposed by the patient not to have begun to act until after the lapse of fifteen minutes. ('Ed. Med. and Surg. Journ.' vol. 59, p. 72.) The symptoms caused by arsenic and other irritants, and, indeed, by all poisons generally, are commonly manifested in from half an hour to an hour. It is rare that the appearance of symptoms is protracted for two hours, except under certain peculiar states of the system. It is said that some neurotic poisons, such as the poisonous mushrooms, may remain in the stomach twelve or twenty-four hours without giving rise to symptoms; and this is also affirmed to be the case with some animal irritants, such as decayed meat; but with regard to the first point, it has been shown by Dr. Peddie that mushrooms have produced symptoms in half an hour; and a case has fallen under my own observation, in which the symptoms from noxious animal food came on within as short a time after the meal, as is commonly observed in irritant poisoning by mineral substances. In cases of poisoning by phosphorus, no symptoms have occurred until after the lapse of some hours.

Influence of disease.—A *diseased* state of the body may render a person comparatively unsusceptible of the action of certain poisons, while in other instances it may increase their action, and render them fatal in small doses. In dysentery and tetanus a person may take, without being materially affected, a quantity of opium sufficient to kill an adult in average health. In mania, cholera, hysteria, and delirium tremens, large doses of opium may be borne with comparative impunity. In a case of hemiplegia, a woman æt. 29, took for six days, three grains of strychnia daily without injurious consequences —the dose having been gradually raised ('Gaz. Méd.' Mai 1845); while one grain of strychnia is commonly regarded as a fatal dose to a healthy adult. In a case of tetanus, Dupuytren gave as much as two ounces of opium at a dose (60 grammes), without serious consequences. (Flandin, 'Traité des Poisons,' vol. 1, p. 231.) It has also been remarked that persons affected with tetanus are not easily salivated by mercury. This morbid state appears to create the power of resisting the ordinary effects of poisons. ('Colles's Lectures,' vol. 1, p. 77.) The effect of certain diseases of the nervous system, as well as of habit, either in retarding the appearance of symptoms or in blunting the operation of a poison, it is not difficult to appreciate; they are cases which can present no practical difficulty to a medical jurist. On the other hand, in certain diseased states of the system, there may be an increased susceptibility of the action of poison. Thus, in those persons who have a disposition to apoplexy, a small dose of opium may act more quickly and prove fatal. In a person labouring under inflammation of the stomach or bowels, there would be an increased susceptibility to the action of arsenic, antimony, or other irritants. In debility from any cause these mineral substances would also act injuriously even in ordinary doses. Antimony is a most powerful depressant, and might, by its effect on the heart, cause death by syncope. The influence of disease in increasing the operation of poison, has been noticed in cases of diseased kidney (granular degeneration), in which small doses of mercury have produced severe salivation, leading to exhaustion and death. In diseases of the lungs affecting aged persons, opium in full medicinal doses, has been observed to exert a poisonous action. The effect of the drug appears to be intensified by the disease. This observation applies equally to morphia. Chloroform vapour in ordinary quantity has been found

to produce fatal effects, in cases in which there was latent disease of the heart or of the coronary arteries of this organ. A fatty condition of the muscular tissue leading to great feebleness of the heart's action, appears to be highly favourable to death by syncope, under the use of chloroform. A knowledge of these facts is of importance in reference to charges of malapraxis when death has arisen from ordinary or extraordinary doses of medicines, administered to persons labouring under disease. In such cases another mode of treatment should be substituted, or a smaller dose than usual given, and its effects carefully watched. In some instances, however, full and large doses of powerful drugs have been recklessly given, and when a fatal result has followed, there has been a strong disposition to refer death to the supposed disease, of which, however, sometimes no trace could be found in the body. An experienced physician, well acquainted with pathological anatomy, informs me that since the use of chloroform has become general, and deaths under its use are not unfrequent, a fattiness and flabbiness of the muscular structure of the heart has been sought for and almost universally found! The fatal result has not been attributed to its real cause, the imprudent or careless administration of chloroform, but to some minute structural changes revealed by the microscope in the substance of the organ!

Symptoms appear during a state of health.—Symptoms of poisoning manifest themselves in a person while in a state of *perfect health*, without any apparent cause. This rule is of course open to numerous exceptions, because the person on whose life an attempt has been made, may be actually labouring under disease; and under these circumstances, the symptoms may be so obscure as often to disarm all suspicion. When poison is secretly given in medicine, a practitioner is very liable to be deceived, especially when the disease under which the person is labouring is of an acute nature, and has been attended by symptoms of disorder in the alimentary canal. Several cases of poisoning have occurred in which arsenic was criminally substituted for or mixed with medicine, and given to persons while labouring under a disorder of the bowels. We are, however justified in saying, with respect to this character of poisoning, that when in a previously healthy person, violent vomiting and purging occur suddenly and without any assignable cause, such as pregnancy, disease, or indiscretion in diet, to account for them, there is strong reason to suspect that irritant poison has been taken. When the person is already labouring under disease, we must be especially watchful on the occurrence of any sudden change in the character or violence of the symptoms, unless such change can be easily accounted for on common or well-known medical principles. In most cases of criminal poisoning we meet with alarming symptoms without any obvious or sufficient natural causes to explain them. The practitioner will of course be aware that there are certain diseases which are liable to occur suddenly in healthy people, the exact cause of which may not at first sight be apparent; therefore this criterion is only one out of many on which a medical opinion should be founded.

2. *In poisoning the symptoms appear soon after a meal or soon after some kind of food or medicine has been taken.*—This is by far the most important character of poisoning in the living body. It has been already stated that most poisons begin to operate within about an hour after they have been swallowed; and although there are a few exceptions to this remark, yet they occur under circumstances easily to be appreciated by a practitioner. Thus, then, it follows that, supposing the symptoms under which a person is labouring, to depend on poison, the substance has most probably been swallowed, either in food or medicine, from half an hour to an hour previously. It must be observed, however, that cases may occur in which the poison has

not been introduced by the mouth. Oil of vitriol and other corrosive liquids have been thrown up the rectum in injections, and have thus caused death; the external application of arsenic, corrosive sublimate, and cantharides to ulcerated surfaces has destroyed life. In one case, arsenic was introduced into the vagina of a female, and she died in five days under all the symptoms of arsenical poisoning. (Schneider, 'Ann. der ges. Staatsarzneikunde,' i. 229.) Such cases are rare, but, nevertheless, the certainty that they have occurred, where their appearance could hardly have been anticipated, shows that in a suspicious case a practitioner should not deny the fact of poisoning, merely because it may be proved that the person could not have taken poison in the usual way, by the mouth. Again, persons may be destroyed by the vapours of ether, chloroform, prussic acid, or other powerful volatile poisons, introduced into the body through the lungs. Such a mode of suicide, or murder, might disarm suspicion, from the fact of no noxious material being found in the stomach.

Let us suppose, however, the circumstances to have been such that these secret means of destruction could not have been resorted to, and that the substance is one of those most commonly selected by a murderer, such as arsenic, tartar emetic, oxalic acid, or corrosive sublimate, then we may expect that this character of poisoning will be made evident to us, and that something must have been *swallowed* by the patient shortly before the alarming symptoms appeared. By observations attentively made, it may be in our power to connect the appearance of the symptoms with the use of a particular article of food, and thus indirectly lead to the detection of a criminal. Supposing that many hours have passed since food or medicine was taken by the patient, without any effect ensuing—it is probable that the symptoms are due to natural causes and not to poison. When symptoms resembling those of poisoning speedily follow the ingestion of food or medicine, there is, however, reasonable ground for suspicion; but caution should be observed in drawing inferences, since the most extraordinary coincidences sometimes present themselves. In the case of *Sir Theodosius Boughton*, who was poisoned by his brother-in-law, *Donellan*, in 1781, the fact of alarming symptoms coming on in *two minutes* after the deceased had swallowed what was supposed to be a simple medicinal draught, was most important as evidence against the prisoner. There is no doubt that laurel-water had been substituted for the medicine by the prisoner, and that this had caused the symptoms which preceded death. The practice of substituting poisonous mixtures for medicinal draughts or powders is by no means unusual, although it might be supposed to indicate a degree of refinement and knowledge not commonly to be found among criminals. Medical practitioners are thus apt to be imposed upon, and the following case, related by a deceased judge, will serve as a caution:—An apothecary prepared a draught, into which another person put poison, intending thereby to destroy the life of the patient for whom the medicine was prescribed. The patient, not liking the taste of the draught, and thinking there was something suspicious about it, sent it back to the apothecary, who, knowing the ingredients of which he had composed it, and wishing to prove to his patient that he had done nothing wrong, drank it himself, and died from the effects. He was thus the unconscious agent of his own death; and though the draught was intended for another, the party who poisoned it was held guilty of murder. This case contains a warning to medical witnesses. It is not unusual, on trials for poisoning, when the poison is conveyed through medicine, to find a medical witness offering to swallow his own dranght in a Court of Law, in order to furnish a convincing practical illustration of the innocence of the medicine! It need hardly be observed that an exhibition of this kind is never required of a medical witness. If

any doubt be raised of the innocent properties of a draught or powder, a chemical analysis of its contents will be far more satisfactory, and attended with no kind of risk to the practitioner.

On the other hand, the occurrence of symptoms resembling those produced by poisoning, soon after food or medicine has been taken, may be a pure coincidence. In such a case, poison is always suspected by the vulgar; and it will be the duty of a medical jurist to guard against the encouragement of such a suspicion, until he has strong grounds to believe it to be well founded. No public retractation or apology can ever make amends for the injury which may in this way be inflicted on the reputation of another; for those who hear the accusation may never hear the defence. In all such cases, a practitioner may entertain a suspicion, but, until confirmed by facts, he should avoid *expressing* it or giving it publicity. When death is not a consequence, it is difficult to clear up such cases, except by the aid of a chemical analysis; but this, as we know, is not always applicable. If death ensue, the real cause is usually apparent, and a suspicion of poisoning is thus often removed by an examination of the body.

3. *In poisoning, when several partake at the same time of the same food or medicine (mixed with poison), all suffer from similar symptoms.*—This character of poisoning cannot always be procured; but it furnishes good evidence of the fact when it exists. Thus, supposing that after a meal made by several persons from the same dish, only one suffers, the suspicion of poisoning is considerably weakened. The poisoned article of food may be detected by observing whether they who suffer under any symptoms of poisoning, have partaken of one particular solid or liquid in common. In a case of accidental poisoning at a dinner-party, a medical man who was present observed that those who suffered had taken port-wine only: the contents of the bottle were examined, and found to be a saturated solution of arsenic in wine. In general, considerable reliance may be placed upon this character, because it is improbable that any common cause of disease should suddenly attack with violent symptoms of a similar kind many healthy persons at the same time, and within a short period after having partaken of food together. We must beware of supposing that, when poison is really present, all will be attacked with precisely similar symptoms; because there are many circumstances which may modify their nature and progress. In general that person who has partaken most freely of the poisoned dish will suffer most severely; but even this does not always follow. There is a well-known case, recorded by Bonnet, where, among several persons who partook of a dish poisoned with arsenic, they who had eaten little and *did not vomit*, speedily died; while others who had partaken largely of the dish, and had in consequence vomited freely, recovered.

It was just now remarked, that there is no disease resembling poisoning which is likely to attack several healthy persons at the same time, and in the same manner. This is undoubtedly true as a general principle, but the following case will show that mistakes may occasionally arise even under these circumstances. It occurred in London, during the prevalence of the malignant cholera in the year 1832. Four of the members of a family, living in a state of great domestic unhappiness, sat down to dinner in apparently good health: some time after the meal, the father, mother, and daughter, were suddenly seized with violent vomiting and purging. The evacuations were tinged with blood, while the blueness of the skin, observed in cases of malignant cholera, was absent. Two of these persons died. The son, who was known to have borne ill-will against his father and mother, and who suffered no symptoms on this occasion, was accused of having poisoned them. At the inquest, however, it was clearly shown by the medical attendant, that the deceased persons

had really died of malignant cholera, and there was no reason to suspect that any poison had been administered to them. In this instance it will be perceived that symptoms resembling those of irritant poisoning appeared suddenly in several individuals in perfect health, and shortly after a meal. We hereby learn that the utility of any rules for investigating cases of poisoning, depends entirely on the judgment and discretion with which they are applied to particular cases.

It is well to bear in mind, in conducting these inquiries, that symptoms resembling those produced by irritant poison, may be sometimes traced to *food*. Meat rendered unwholesome by disease or decay, pork, bacon, sausages, cheese and bread, as well as certain kinds of shell-fish, may give rise to symptoms of poisoning, and even cause death. Such cases may be regarded as poisoning by animal or vegetable irritants. All the characters above described, as indicative of poisoning, may be observed, and the difficulty of forming an opinion is often increased by the fact that some of the persons attacked may have previously partaken of the same kind of food without inconvenience.

4. *The discovery of poison in the food taken or in the matters vomited.*—One of the strongest proofs of poisoning in the living subject, is the detection of poison by chemical analysis, or, if of a vegetable nature, by a microscopical examination, either in the food taken by the person labouring under its effects, or in the matters vomited, or, after the lapse of a few hours, in the urine. The evidence is of course more satisfactory when the poison is detected in the matters vomited or in the urine, than in the food; because this will show that it has really been taken, and it will readily account for the symptoms. If the vomited matters have been thrown away, we must examine the food of which the patient may have partaken. Should the results in both cases be negative, and no trace of poison be found in the urine, it is probable that the symptoms were due to disease.

In investigating a case of poisoning in a living subject, a medical jurist must remember, that poisoning is sometimes *feigned*, and at others *imputed*. It is easy for an artful person to put poison into food, as well as to introduce it into the matters vomited or discharged from the bowels, and to accuse another of having administered it. There are few of these accusers who go so far as to swallow poison under such circumstances, as there is a great dread of poisonous substances among criminals; and it will be at once apparent, that it would require a person well versed in toxicology to feign a series of symptoms which would impose upon a practitioner at all acquainted with the subject. In short, the difficulty reduces itself to this:—What inference can be drawn from a chemical detection of poison in food? All that a medical man can say is, whether poison is or is not present in a particular article of food: he must leave it to the authorities of the law to develope the alleged attempt at administration. If the poison has been actually administered or taken, then we should expect to find that the person had suffered from the usual symptoms. The absence of these symptoms would be a strong fact against the alleged administration. The detection of poison in the matters vomited, affords no decisive proof that it has been swallowed, except under two circumstances:—1. When the accuser has previously laboured under the usual symptoms of poisoning, in which case there can be no feigning, and the question of imputation is a matter to be established by general evidence. 2. When the matters are actually vomited into a *clean vessel* in the presence of the medical attendant himself, or of some person on whose testimony perfect reliance can be placed. The detection of absorbed poison in the *urine* or *saliva*, furnishes a clear proof that poison has been taken, that it has passed into the blood, and has been subsequently eliminated by the kidneys or the salivary organs.

CHAPTER 12.

ON THE EVIDENCE OF POISONING IN THE DEAD BODY — PERIOD AT WHICH POISONS PROVE FATAL — CHRONIC POISONING — APPEARANCES PRODUCED BY THE DIFFERENT CLASSES OF POISONS — REDNESS OF THE MUCOUS MEMBRANE MISTAKEN FOR INFLAMMATION — ULCERATION AND CORROSION — SOFTENING — PERFORATION OF THE STOMACH FROM POISON AND DISEASE.

SUPPOSING that the person is dead, and we are required to determine whether the case is one of poisoning or not, we must, in the first instance, endeavour to ascertain all the particulars which have been considered in the last chapter, as indicative of poisoning in the living subject. Should the deceased have died from poison, the circumstances of the attack, and the symptoms preceding death, ought to correspond with the characters already described; and in these investigations, it is well to bear in mind the following rule:—There is no one symptom or pathological condition which is peculiar to poisoning; but at the same time there is probably no disease which presents *all* those characters which are met with in a special case of poisoning. The additional evidence to be derived from the *death* of a person, may be considered under the following heads:—

1. *The time at which death takes place after the first occurrence of symptoms.*—This question requires examination, because the more common poisons, when taken in fatal doses, generally cause death within definite periods of time. By an attention to this point, we may, in some instances, be enabled to negative a charge of poisoning, and in others to form an opinion of the kind of poison which has been taken. In a Court of Law a medical practitioner is often required to state the usual *period of time* within which poisons prove fatal. It is to be observed that, not only do poisons differ from each other in this respect, but that the same substance, according to the form or quantity in which it has been taken, may differ in the rapidity of its action. A large dose of prussic acid, *i.e.* from half an ounce to an ounce, may destroy life in less than two minutes. In ordinary cases of poisoning by this substance a person dies, *i.e.* all signs of life have commonly ceased in from ten to twenty minutes: if he survives half an hour, there is some hope of recovery. In the case of seven epileptics, accidentally poisoned by a similar dose of this acid in one of the Parisian hospitals, the first died in about twenty minutes, the seventh survived three-quarters of an hour. Oxalic acid, one of the most energetic of the common poisons, when taken in a dose of from half an ounce to an ounce, may destroy life in from ten minutes to an hour: if the poison is not perfectly dissolved when swallowed, it is a longer time in proving fatal. The strong mineral acids in poisonous doses, destroy life in about eighteen or twenty-four hours. Arsenic under the form of arsenious acid (white arsenic), operates fatally in from eighteen hours to three or four days. It has, however, in more than one instance, killed a person in two hours. Opium, either as a solid or in the form of laudanum, commonly proves fatal in from six to twelve hours; but it has been known in several instances, to destroy life in less than three hours: they who survive the effects of this poison for twelve hours, are considered to have a fair chance of recovery. This must be understood to be merely a statement of the average results, as nearly as we are warranted in giving an opinion; but the medical jurist will of course be aware that the fatal period may be protracted or shortened, according to all those circumstances which have been elsewhere stated to affect the action of poisons.

There are various forms which this question may assume. It may be said that the death of a person, alleged to have taken poison, has occurred too rapidly or too slowly to justify a suspicion of poisoning. The following case will serve as an illustration: A woman of the name of *Russell* was tried and convicted at the Lewes Summer Assizes, in 1826, for the murder of her husband, by poisoning him with arsenic. The poison was detected in the stomach; but the fact of poisoning was disputed by some medical witnesses for this among other reasons, that the deceased had died *three* hours after the only meal at which the poison could have been administered to him. The authority of Sir A. Cooper and others was cited to show that, according to their experience, they had never known a case of poisoning by arsenic to have proved fatal in less than seven hours. This may be admitted, but, at the same time, there was sufficient authority on the other side to establish that some cases had actually proved fatal in three or four hours. So far as this objection was concerned, the prisoner was properly convicted. In reference to the medical question raised at this trial, I may observe that two distinct cases have occurred in which the individuals died certainly within *two hours* after taking arsenic; and several instances have been reported, in which death has taken place in from three to four hours after the administration of this poison. It seems extraordinary in the present day, that any attempt should have been made by a professional man to negative a charge of criminal poisoning upon so weak a ground as this; but this opinion was expressed many years ago, when the facts connected with poisoning were but little known. It is quite obvious that there is nothing so far as we know, to prevent arsenic from destroying life in an hour, or even within a shorter period. A case will be hereinafter related, in which death took place from arsenic probably within twenty minutes. These matters can be settled only by a careful observation of numerous cases, and not by any *à priori* reasoning, or by a limited individual experience.

In all instances of sudden death there is generally a strong tendency on the part of the public to suspect poisoning. They do not consider that persons may die a natural death *suddenly*, as well as slowly; or, as we shall presently see, that death may really take place slowly, and yet be due to poison. This prejudice continually gives rise to the most unfounded suspicions of poisoning, and, at the same time, leads to cases of chronic or slow poisoning being frequently mistaken for natural disease. One of the means recommended for distinguishing narcotic poisoning from apoplexy or disease of the heart, is the difference in the rapidity with which death takes place. Thus, apoplexy or disease of the heart may prove fatal either instantly or within an hour. The only poisons likely to operate with such fatal rapidity, are prussic acid or nicotina. Poisoning by opium is commonly protracted for five or six hours. This poison has never been known to destroy life instantaneously, or within a few minutes. Thus, then, it may happen that death will occur with such rapidity as to render it impossible, under the circumstances, to attribute it to narcotic poison.

Chronic poisoning.—When a poison destroys life rapidly, it is called a case of *acute* poisoning, to distinguish it from the *chronic* form, *i.e.* in which death takes place slowly. Chronic poisoning is a subject which has of late frequently required medico-legal investigation. Most poisons, when their effects are not rapidly manifested owing either to the smallness of the dose or to timely treatment, are capable of slowly undermining the powers of life, and killing the patient by producing emaciation and exhaustion. This is sometimes observed in the action of arsenic, corrosive sublimate, and tartarized antimony, but it has been remarked also in cases of poisoning by the mineral acids and caustic alkalies. Death is here an indirect consequence;—

in poisoning by the acids or alkalies, either stricture of the gullet is induced, or the lining membrane of the stomach is destroyed, and the process of digestion impaired, a condition which leads to exhaustion and death. The time at which these indirect effects may prove fatal, is of course liable to vary. A person has been known to die from a stricture of the gullet, brought on by sulphuric acid, *eleven months* after the poison was swallowed; and there is no reason to doubt that instances may occur of a still more protracted nature. In cases of *chronic poisoning* there is sometimes great difficulty in assigning death exclusively to the original action of the poison, since the habits of life of the person, a tendency to disease, and other circumstances, may have concurred either to accelerate or produce a fatal result. To connect a stricture of the gullet proving fatal, with the effects of poisoning by a mineral acid, it would be necessary to show that there was no tendency to this disease before the acid was administered: that the symptoms appeared soon after the first effects of the poison went off: that these symptoms continued to become aggravated until the time of death, and lastly that there was no other cause to which death could with any probability be referred. These remarks apply equally to the secondary fatal effects of any poison, such, for instance, as the salivation occasionally induced by corrosive sublimate, and the exhaustion and depression which are caused by tartarized antimony, when the acute symptoms of poisoning by these substances have passed away.

Several cases have come before our tribunals, in which the facts connected with this form of poisoning were of some importance. I allude to those of Miss *Blandy*, tried at Oxford, in 1752, for the murder of her father by arsenic; and of a woman named *Butterfield*, tried at Croydon in 1775, for the murder of a Mr. Scawen, by administering corrosive sublimate. Among cases of recent occurrence, may be mentioned that of Mrs. Wooler (*Reg.* v. *Wooler*, Durham Winter Assizes, 1855), in which it was clearly proved that the deceased had been under the influence of arsenic, administered at intervals in repeated doses, for a period of about seven weeks before her death. She died from exhaustion and the secondary effects of the poison. In three other cases tartarized antimony was the poison selected. It was given in repeated doses, over different periods, and caused death, by the specific effects of poisoning in a chronic form. 1. The case of *Ann Palmer*. ('Guy's Hospital Reports,' October 1857.) 2. The case of *M'Mullen* (Liverpool Summer Assizes, 1856), in which a woman was tried and convicted for causing the death of her husband; and 3rd, the case of *Reg.* v. *Hardman* (Lancaster Summer Assizes, 1857), in which a man was convicted of the murder of his wife. In most cases, murderers destroy life by administering poison in large doses; but in the instances referred to, small doses were given at intervals, a fact which, in some of them, led to a medical doubt of the real cause of the symptoms. The case of *Isabella Banks* (*Reg.* v. *Smethurst*, Central Criminal Court, August, 1859) gave rise to a conflict of medical opinion respecting the cause of death. Drs. Julius and Bird, who attended the deceased throughout her illness of about a month's duration, the late Dr. Todd, and myself, referred the symptoms and cause of death to chronic poisoning by antimony and arsenic, and in confirmation of this opinion, antimony was distinctly found by Dr. Odling and myself in the intestines after death. Arsenic was also found in an evacuation passed by the deceased three days before her death. Dr. Tyler Smith, Dr. Richardson, and others, who did not see the deceased, ignoring the existence of antimony in the body, referred the symptoms and appearances partly to pregnancy, and partly to a sudden attack of severe dysentery. The jury found the accused guilty, but upon the medical doubt thus raised in the public mind respecting the cause of death, the accused was subsequently discharged.

A similar question arose in *Reg.* v. *Winslow.* (Liverpool Autumn Assizes, 1860). The prisoner was charged with the murder of a Mrs. James by administering to her small doses of antimony. The suspicions of Dr. Cameron, who attended deceased, were excited by the intermittent and violent nature of the vomiting, as well as by the extreme depression. Antimony was found in the urine and fæces by Dr. Edwards; and, after death, this substance was discovered, in small quantity, in the viscera, by Dr. Edwards, the late Dr. Miller, and myself. The deceased was at the time labouring under malignant disease of the cæcum, but it was alleged that the antimony had accelerated her death. The jury acquitted the accused. The examination of the bodies of the sister of deceased, as well as of two other members of the family, led to the discovery of antimony also in small quantity, in the viscera of each; and from the nature of the symptoms preceding death, as well as the general healthiness of the organs, no doubt was entertained by the medical witnesses that all these persons, members of the same household, had died from the effects of antimony administered at intervals in small doses. The law could not fix the perpetration of these four murders upon any person, and three would have wholly escaped public notice, but for the death of Mrs. James some months after the bodies of the others had been buried under medical certificates setting forth natural causes of death! A set of cases somewhat similar has been recently brought to light by certain inquests on exhumed bodies at Bilston in Staffordshire (December, 1871). Three children in a family died at different times, under similar symptoms. Dr. Hill, of Birmingham, found antimony in two of the bodies, and the body of a third child was exhumed after two months' burial, and antimony was also found in it. It appears that this child died on October 10, and its death was registered on the 13th of that month as death from 'asthenia,' and 'gastric fever' 'six days!' They all received medical attendance, and their names it is stated were entered in some burial club!

The occurrence of such cases as these, suggests grave reflections on the insecurity of life, when poison is used with skill and cunning, and they demonstrate the inefficiency of the present system of registering causes of death. The editor of the Law Magazine has said, in commenting upon the *Smethurst* case, 'All that is requisite for future murderers by poison to do, is to use small doses, combine the use of various destructive drugs, and subpœna the proper medical witnesses for the defence.' ('Law Magazine, Nov. 1859, p. 145.)

These cases show that medical men in signing certificates, do not sufficiently inquire into the nature of the fatal illness, or the cause of death (see 'Lancet,' 1870, vol. i. p. 341): but this is an evil which admits of an easy remedy. The public have much more to dread in the fact that, even in plain cases of poisoning, some physicians of experience and repute have been unable to discriminate the symptoms from those of natural disease. Thus, in the notorious case of *William Palmer*, one physician who appeared for the defence, affirmed that the symptoms under which Cook died were those of angina pectoris; while another physician, also employed for the defence, assigned death to epilepsy with tetanic complications! The witnesses came forward as experts to maintain these views, and to induce the Court and jury, as well as the public, to adopt one or the other. In reference to the death of *Ann Palmer*, which was caused by doses of antimony, the solid sulphide of this metal was found in the stomach after death, while the metal itself pervaded the whole of the tissues, a respectable physician, with only a superficial knowledge of the real facts of the case, wrote a pamphlet to prove that she had died from an attack of common cholera! If these gentlemen had been called in to attend these two victims of secret poisoning while living, it is

quite obvious that they would have had no suspicion of poisoning, and that they would have respectively certified that death was caused in the one case by angina pectoris or epilepsy, and in the other by cholera. They would thus have effectually screened, under erroneous medical certificates, the acts of a man who is now universally admitted to have been the greatest criminal of the age. If physicians of some standing and professed experts, can thus overlook ordinary cases of poisoning, it is not surprising that general medical practitioners, who have not given special attention to the subject of toxicology, should fall into the error of granting erroneous medical certificates, and of certifying that death from arsenic or opium was due to cholera, convulsions, or apoplexy!

The characters of chronic poisoning have of late years acquired a special interest for the medical jurist. There is a difficulty about them which no accuracy of observation or judgment can surmount. The poison or poisons, if found in the dead body at all, must necessarily exist in fractional parts of a grain. This alone will be sufficient to create a doubt whether death has been caused by the poison, although it is quite consistent with medical experience that a person may die from chronic poisoning, and little or none of the poison be found in the body after death. In the case of Mrs. James (*Reg. v. Winslow*), not more than the tenth part of a grain was found in the whole of the tissues of the body: in the case of Isabella Banks (*Reg. v. Smethurst*), the quantity was greater than this, but less than a grain altogether; while in the case of Mrs. *Peters*, of Yeovil, examined by the late Mr. Herapath, *none* was found in the body, although this chemist had extracted a quantity of antimony as sulphide from the urine of deceased, in less than nine days before her death! In this case Dr. Garland had also found antimony in the evacuations during life, and had referred the intermittent irritation of the stomach and bowels, from which deceased had suffered, to the secret use of this mineral. The jury returned a verdict that deceased had died from disease and that death was accelerated by some irritant. ('Lancet,' August 4th, 1860, p. 119.) On some recent trials for poisoning it has been a contested scientific question, whether a person can die from poison and no trace of the poison remain in the body. The late Mr. Herapath's evidence in Mrs. Peters' case not only now proves the affirmative, but goes to show that antimony may act fatally and be entirely eliminated from the system in about a week. ('Med. Times and Gaz.' Aug. 25, Sept. 15, and 29, 1860, pp. 190, 271, 317.)

2. *Evidence from appearances in the body.*—One of the chief means of determining whether a person has died from poison, is an examination of the body after death. In relation to *external* appearances, there are none which are specially indicative of poisoning upon which we can safely rely. It was formerly supposed that the bodies of persons who were poisoned, putrefied more rapidly than those of others who had died from natural disease; and evidence for or against poisoning was at one time derived from the external appearance of the body. This is now known to be an error: the bodies of persons poisoned are not more rapidly decomposed, *cæteris paribus*, than those of others who have died a sudden and violent death from any cause whatever.

Irritant poisons act chiefly upon the stomach and intestines, which they irritate, inflame, and corrode. We may likewise meet with all the consequences of inflammation, such as softening, thickening, ulceration, perforation, or gangrene. Sometimes the coats of the viscera are thickened, at other times thinned and softened, by the action of an irritant.

Neurotic (*Cerebral and Spinal*) poisons do not commonly leave any well-marked appearances in the body. The stomach and intestines present no unnatural changes. There may be greater or less fulness of the vessels of the brain and spinal marrow, as well as of their membranes; but even this is

often so slight as to escape notice, unless attention be particularly directed to these organs. Effusion of blood is rarely found.

The *Narcotico-irritant* or *Cerebro-spinal* poisons may affect either the brain or the stomach and bowels, and commonly all these parts according to their peculiar mode of action.

It is important to bear in mind, that both Irritants and Neurotics may destroy life without leaving any appreciable changes in the body. To such cases as these, the remarks about to be made do not apply. The proofs of poisoning must, in such exceptional cases, be procured entirely from other sources. Any evidence derivable from the appearances in the body of a person poisoned, will be imperfect unless we are able to distinguish them from those analogous changes often met with as the results of ordinary disease. These are confined to the mucous membrane of the stomach and bowels. They are redness, ulceration, softening, and perforation. Each of these conditions may depend upon disease, as well as upon the action of irritant poisons.

Redness.—It is a main character of the irritants to produce, as a result of inflammation, redness of the mucous or lining membrane of the stomach and small intestines. This redness, when first seen, is usually of a deep crimson colour, becoming brighter by exposure to air. It may be diffused over the whole mucous membrane: at other times it is seen in patches, dots, or lines (striæ), spread irregularly over the surface of the stomach. It is sometimes met with at the smaller, but more commonly at the larger end of this organ, and again we occasionally find the folds or prominences only of the mucous membrane presenting this red or inflamed appearance. Redness of the mucous membrane may, however, be due to gastritis or gastro-enteritis as a result of disease; and in order to assign the true cause of the inflammation, it will be necessary to have an account of the symptoms preceding death, or some chemical proof of the existence of irritant poison in the contents of the stomach or the tissues of the body.

In the healthy state, the mucous membrane of the stomach is pale and white, or nearly so, except during digestion, when it is slightly reddened; and some observers have remarked that a slight redness has often remained in the stomachs of those who have died during the performance of the digestive process. When in contact with the spleen or liver, after death, the stomach is apt to acquire a deep livid colour from the transudation of blood; and it is well known that the bowels acquire a somewhat similar colour from the gravitation of blood which always takes place after death. None of these appearances are likely to be mistaken for the action of an irritant poison.

There is an important class of cases in which redness of the mucous membrane of the stomach is found after death, not dependent on the action of poison or on any easily assignable cause. These cases, owing to their being so little known, and involved in much obscurity, deserve the attention of a medical jurist, since the appearances closely resemble those produced by irritant poison. A person may die without suffering from any symptoms of disordered stomach; but on an inspection of the body, a general redness of the mucous membrane of this organ will be found, not distinguishable from the redness which is so commonly seen in arsenical poisoning. Several cases of this kind have occurred at Guy's Hospital: and drawings which have been made of the appearances presented by the stomach, are preserved in the Museum collection.

The redness of the lining membrane of the stomach, in cases of poisoning, is so speedily altered by putrefaction, when circumstances are favourable to this process, as frequently to render it impossible for a witness to speak with any certainty upon its cause. Putrefactive infiltration from the blood contained in the adjacent viscera and muscles, will give a reddish-coloured

appearance to a stomach otherwise in a healthy condition. Great dispute has arisen respecting the length of time during which redness of the stomach produced by an irritant, will be recognizable and easily distinguishable from putrefactive changes. It is sufficient to say, that no certain rule can be laid down on the subject: it must be left to the knowledge and discretion of the witness. I have distinctly seen the well-marked appearances of inflammation produced by arsenic in the stomach and duodenum in an exhumed body twenty-eight days after interment (*Reg.* v. *Jennings*, Berks Lent Ass. 1845); and in another instance, referred to me by Mr. Lewis, the coroner for Essex, in August, 1846, the reddened state of the mucous membrane, in a case of arsenical poisoning, was plainly perceptible on removing a layer of arsenic, *nineteen months* after interment. (See on this question, a case of suspected poisoning by Orfila, 'Annales d'Hyg.' 1839, 1, 127.) If, however, there should be a reasonable doubt respecting the cause of redness, and no poison is detected, it would be unsafe to rely upon this appearance as evidence of poisoning.

Ulceration.—In irritant poisoning, the stomach is occasionally found ulcerated: but this is, comparatively speaking, a rare occurrence. In such cases the mucous membrane is removed in small distinct circular patches, under the edges of which the poison (arsenic) may be found. Ulceration of the stomach is a more common result of disease, than of the action of poison. As a consequence of disease, it is very insidious, going on often for weeks together, without giving any indications of its existence, except perhaps slight gastric disturbance with occasional nausea, vomiting and loss of appetite. In this case, the ulceration is commonly seen in small circumscribed patches. It is worthy of remark, as a means of distinction, that ulceration has never been known to take place from arsenic or any irritant poison, until symptoms indicative of irritant poisoning have occurred. In ulceration from disease, the mucous membrane is commonly only reddened in the neighbourhood of the ulcer. In ulceration from poison, the redness is generally diffused over other parts of the stomach, as well as over the duodenum and small intestines. A case, however, occurred in Guy's Hospital, some years ago, in which, with a small circular patch of ulceration near the cardiac opening, the whole mucous membrane was red and injected; but this singular condition of the stomach, so closely resembling the effects of an irritant poison, was unaccompanied by any marked symptoms of irritation during life. The history of a case previous to death will thus commonly enable us to determine to what cause the ulceration found, may be due. Care must be taken to distinguish ulceration from *corrosion*. Ulceration is a vital process: the substance of a part is removed by the absorbents as a simple result of inflammation. Corrosion, on the other hand, is a chemical action;—the parts are removed by the immediate contact of the poison: they are decomposed: their vitality is destroyed, and they combine with the corrosive matter itself. Ulceration requires time for its establishment, while corrosion is either an instantaneous or a very rapid effect.

Softening.—The coats of the stomach are not unfrequently found so soft as to yield and break down under very slight pressure; and this may be the result either of poisoning, of some spontaneous morbid change in its structure during life, or of the solvent action of the gastric juice after death. As this condition of the stomach, when caused by poison, is produced by those substances only which possess corrosive properties, it follows that in such cases, traces of their action will be perceived in the mouth, throat, and gullet. In softening from disease, the change will be confined to the stomach alone, and it is commonly found only at the cardiac or greater end of the organ. When softening is really caused by an irritant poison, it is generally attended by

other striking and unambiguous marks of its operation. Softening is not to be regarded as a common character of poisoning: it is only an occasional appearance. I have met with an instance in which the coats of the stomach were considerably hardened by sulphuric acid. Softening can never be inferred to have proceeded from poison, unless other well-marked changes are present, or unless the poison is discovered in the softened parts. The stomachs of infants have been frequently found softened from natural causes: such cases could not be mistaken for poisoning, since the history of them during life, the want of other appearances indicative of poisoning, and the total absence of poison from the viscera, would prevent such a suspicion from being entertained.

Perforation.—The stomach may become perforated, either as a result of poisoning or disease.

Perforation from poisoning.—This may arise:—1, from corrosion; 2, from ulceration. The perforation by *corrosion* is by far the most common variety of perforation from poisoning. It is occasionally witnessed when the strong mineral acids have been taken, especially sulphuric acid:—the stomach, in such cases, is blackened and extensively destroyed, the aperture is large, the edges are rough and irregular, and the coats are easily lacerated. The acid escapes into the abdomen, and may be readily detected there by chemical analysis. The perforation from *ulceration*, caused by irritant poison (arsenic), is but little known. There are but few instances on record. In a great number of poisoned subjects examined during many years past at Guy's Hospital, not a single case has occurred. It must, then, be looked upon as a rare appearance in cases of irritant poisoning.

Perforation from disease.—This is by no means an unusual condition. Many cases of this disease will be found reported elsewhere. ('Guy's Hosp. Rep.' No. 8.) It is invariably fatal when it proceeds so far that the contents of the stomach escape into the abdomen; but sometimes the stomach becomes glued to the pancreas or other organs during the ulcerative process, and then the person may recover. Several instances of this kind of adhesion have been met with in inspections. The symptoms from perforation commonly attack a person suddenly, while apparently enjoying perfect health. Hence these cases may be easily mistaken for those of irritant poisoning. The principal facts observed with regard to this formidable disease are the following: 1. It often attacks young women from eighteen to twenty-three years of age. 2. The preceding illness is extremely slight; sometimes there is merely loss of appetite, or a capricious appetite with uneasiness after eating. 3. The attack commences with a sudden and most severe pain in the abdomen, generally soon after a meal. In irritant poisoning the pain usually comes on gradually, and slowly increases in severity. 4. Vomiting, if it exists at all, is commonly slight, and is chiefly confined to what is swallowed. There is no purging: the bowels are generally constipated. In irritant poisoning the vomiting is usually severe, and purging seldom absent. 5. The person dies commonly in from eighteen to thirty-six hours: this is also the average period of death in the most common form of irritant poisoning, *i.e.* by arsenic; but in no case yet recorded has arsenic caused perforation of the stomach within twenty-four hours; and it appears probable that a considerable time must elapse before such an effect could be produced by this or any irritant. 6. In perforation from disease, the symptoms and death are clearly referable to peritonitis. 7. As a result of disease, the aperture is commonly of an oval or rounded form, about half an inch in diameter, situated in or near the lesser curvature of the stomach, and the edges are smooth. The outer margin of the aperture is often blackened, and the aperture itself is funnel-shaped from within outwards, *i.e.* the mucous coat is the most removed, and the outer or peritoneal coat, the

least. The coats of the stomach, round the edge of the aperture, are usually thickened for some distance; and when cut they have almost a cartilaginous hardness. These characters of the aperture will not alone indicate whether it is the result of poisoning or disease; but the absence of poison from the stomach, with the want of other characteristic marks of irritant poisoning, would enable us to say that disease was the cause. Besides, the history of the case during life would materially assist us in our judgment. The great risk in all these cases is, that the effects of disease may be mistaken for those of poisoning; for we are not likely to mistake a perforation caused by irritant poison for the result of disease. Notwithstanding the well-marked differences above described, it is common to meet with cases of imputed poisoning where death has really occurred from peritonitis following perforation from disease. I have been required to examine several cases of this kind: one of them will be found elsewhere recorded. ('Guy's Hosp. Reports,' Oct. 1850, p. 226.) In another, the body was exhumed after several months' burial, and the stomach was found perforated from disease in the usual situation.

Spontaneous or Gelatinized perforation.—The stomach is occasionally subject to a spontaneous change by which its coats are softened, and they give way generally at the cardiac or greater end. As the effusion of the contents of the organ in such a case never give rise to peritoneal inflammation, and no symptoms occur prior to death to indicate the existence of so extensive a destruction of parts, it is presumed to be a change in the dead body, and the coats of the stomach are supposed to undergo a process of solution or digestion. It is commonly attributed to the solvent action of the gastric juice, the spleen, diaphragm, and other viscera being sometimes softened. My colleague, Dr. Wilks, who for many years conducted the inspections at Guy's Hospital, informs me that this post-mortem or cadaveric perforation of the stomach is so rare a condition, that it is not met with once in five hundred cases. In two cases in which it was observed, one patient had died from albuminuria and the other from head affection; but in neither of these could there be found any peculiarities regarding their food, the time of the last meal, or the state of the bodies, to account for the spontaneous destruction of the coats of the stomach. (For remarks on this subject by Dr. Budd, see 'Med. Gaz.' vol. 39, p. 895.) In January 1845, I met with an instance of this perforation in a child between two and three years of age. It was seized with convulsions, became insensible, and died twenty-three hours afterwards. After death, the greater end of the stomach was found destroyed to the extent of three inches, and the edges were softened and blackened. There was no food in the stomach, and nothing had passed into the organ for thirty-two hours before death! It was therefore impossible to ascribe death to the perforation, or the perforation to poison. (For a full account of this case, see 'Med. Gaz.' vol. 36, p. 32.) An inspection of the body, with a general history of the case, will commonly suffice to remove any doubt in forming an opinion whether the extensive destruction so commonly met with, has or has not arisen from poison. Thus, in a cadaveric perforation, the aperture is generally situated in that part of the stomach which lies to the left of the cardia; it is very large, of an irregular form, and ragged and pulpy at the edges, which have the appearance of being scraped. The mucous membrane of the stomach is not found inflamed. There is occasionally slight redness, with dark brown or almost black lines (striæ) in and near the dissolved coats, which have an acid reaction. It can only be confounded with perforation by the action of corrosives; but the well-marked symptoms during life, and the detection of the substance after death, together with the changes in the throat and gullet, will at once indicate the perforation produced by corro-

sive poison. A case of extensive perforation of the stomach, as the result of the action of the gastric fluids, has been reported by Dr. Barnes. (See 'Med. Gaz.' vol. 41, p. 293.)

CHAPTER 13.

RULES TO BE OBSERVED IN INVESTIGATING A CASE OF POISONING—THE INSPECTION OF THE BODY—THE EXHUMATION OF BODIES—IDENTITY OF SUBSTANCES—PRESERVATION OF ARTICLES FOR ANALYSIS—USE OF NOTES—MEDICO-LEGAL REPORTS.

When a practitioner is called to a case of poisoning, it is necessary that he should know to what points he ought to give his attention. It is very proper that every effort should be made by him to save life when the individual is living; but while engaged in one duty, it is also in his power to perform another, supposing the case to be one of suspected criminal poisoning, namely, to note down many circumstances which may tend to detect the perpetrator of a crime. There is no person so well fitted to observe these points as a medical man; but it unfortunately happens, that many facts important as evidence are often overlooked. The necessity for observing and recording them is not perhaps generally known. A medical man need not make himself officious on such occasions, but he would be unmindful of his duty as a member of society, if he did not aid the course of justice by extending his scientific knowledge to the detection of crime. It is much to the credit of the medical profession that the crime of murder by poisoning, a form of death from which no caution or foresight can protect a person, is so frequently brought to light, by the announcement of suspicious facts of a medical nature to magistrates and coroners; and on several occasions the highest compliments have been passed by judges on medical practitioners who have been thus indirectly the means of bringing atrocious criminals to the bar of justice.

The following appear to me to be the principal points which demand the attention of a medical jurist in all cases of suspected poisoning: 1. With respect to

Symptoms.

1. The time of their occurrence,—their nature. 2. The exact period at which they were observed to take place after a meal, or after food or medicine had been taken. 3. The order of their occurrence. 4. Whether there was any remission or intermission in their progress, or whether they continued to become more and more aggravated until death. 5. Whether the patient had laboured under any previous illness. 6. Whether the symptoms were observed to recur more violently after a particular meal, or after any particular kind of food or medicine. 7. Whether the patient has vomited:—the vomited matters, if any (especially those *first* ejected), should be procured: their odour, colour, and acid or alkaline reaction noted, as well as their quantity. 8. If none be procurable, and the vomiting has taken place on the dress, furniture, or floor of a room—then a portion of the clothing, sheet, or carpet, may be cut and reserved for analysis;—if the vomiting has occurred on a deal floor, a portion of the wood may be scraped or cut out:—or if on a stone pavement, then a clean piece of sponge soaked in distilled water may be used to remove any traces of the substance. Some years since, an animal was

poisoned with arsenic. None of the poison could be detected in the stomach, but it was easily found in a portion of deal floor, rendered humid by the liquid matters which the animal had vomited during the night. The vessel in which vomited matters have been contained will often furnish valuable evidence, since heavy mineral poisons fall to the bottom, or adhere to the sides. 9. Endeavour to ascertain the probable nature of the food or medicine last taken, and the exact *time* at which it was taken. 10. Ascertain the nature of *all* the different articles of food used at a meal. 11. Any suspected articles of food, as well as the vomited matters, should be sealed up as soon as possible in a clean glass-vessel, labelled, dated, and reserved for analysis. 12. Note down, in their own words, all explanations voluntarily made by parties present, or who are supposed to be concerned in the suspected poisoning. 13. Whether more than one person partook of the food or medicine:—if so, whether all these persons were affected, and how? 14. Whether the same kind of food or medicine had been taken before by the patient or other persons without ill effects following. In the event of the *death* of the patient, it will be necessary for the practitioner to note down—15. The *exact time* of death, if known, and thus determine how long a period the person has survived after having been first attacked with the suspicious symptoms. 16. Observe the attitude and position of the body. 17. Observe the state of the dress. 18. Observe all surrounding objects. Any bottles, paper-packets, weapons, or spilled liquids lying about should be collected and preserved. 19. Collect any vomited matters near the deceased. Observe whether vomiting has taken place in the recumbent position or not. If the person has vomited in the erect or sitting posture, the front of the dress will commonly be found covered with the vomited matters.

Inspection of the Body.

20. Note the external appearance of the body, whether the surface is livid or pallid. 21. Note the state of the countenance. 22. Note all marks of violence on the person, or discomposure of the dress, marks of blood, &c. 23. Observe the presence or absence of warmth or coldness in the legs, arms, abdomen, mouth, or armpits. 24. The presence of rigidity or cadaveric spasm in the body. To give any value to the two last-mentioned characters, it is necessary for the practitioner to observe the nature of the floor on which the body is lying—whether the body be clothed or naked, young or old, fat or emaciated. These conditions create a difference, in respect to the cooling of the body and the access of rigidity. 25. If found dead—When was the deceased last seen living, or known to have been alive? 26. Note all circumstances leading to a suspicion of suicide or murder. 27. The time after death at which the inspection is made. 28. Observe the state of the abdominal viscera. If the stomach and intestines are found inflamed, the seat of inflammation should be exactly specified; also all marks of softening, ulceration, effusion of blood, corrosion, or perforation. The stomach should be removed and placed in a *separate vessel*, ligatures being applied to the two ends. If cut open for examination at this period, this should be performed in a clean dish, and with such care that none of the contents are lost or are allowed to mix with the contents of the intestines. 29. The fluids of the stomach, if this organ is opened during the inspection, should be collected in a clean *graduated* vessel:—notice *a*, the quantity; *b*, the odour tried by several persons; *c*, the colour; *d*, acid or alkaline reaction; *e*, presence of blood, mucus, or bile; *f*, presence of undigested food; and here it may be as well to observe, that the presence of farinaceous matters (bread) would be indicated by the

addition of iodine water, if the contents were not alkaline—of fat, by heat; *g*, other special characters. 30. The contents of the duodenum should be separately collected, ligatures being applied to it. 31. Observe the state of the large intestines, especially the rectum, and note the condition of their contents. The discovery of hardened fæces in the rectum would prove that purging had not existed recently before death. In one case which I was required to examine, this became a question of considerable importance. 32. The state of the windpipe, throat, and gullet, whether there are in these parts any foreign substances, or marks of inflammation and corrosion. This is of essential importance, as it throws a light upon the question, whether the poison swallowed was irritant or corrosive, and whether it had or had not a local chemical action. It also removes any doubt which might arise respecting death by suffocation from mechanical causes. 33. The state of the lungs and heart; all morbid changes noted. 34. The state of the brain and spinal marrow. 35. The condition of the uterus, ovaries, and genital organs should be examined, as poison has been sometimes introduced into the system by the vagina. 36. The liver with the gall bladder should be removed for a chemical examination. 37. The urinary bladder, with any fluid contained in it, should be removed and placed in a separate jar.

Such are the points to which, in the greater number of cases of suspected poisoning, a medical jurist should attend. By means of these data, noted according to the particular case to which they are adapted, he will in general be enabled, without difficulty, to determine the probable time of death, and the actual means by which death was brought about. He may thereby have it in his power also to point out the dish or article of food which had contained the poison, if the case be one of poisoning; and to throw light upon any disputed question of suicide or murder in relation to the deceased. Many cases of poisoning are rendered obscure, owing to these points not having been attended to in the first instance.

I have not considered it necessary to enter into any details respecting the mode of performing an *inspection*. This the practitioner will have acquired during his study of anatomy: and the only essential points in addition to those mentioned are, 1. To examine all the important organs for marks of natural disease: and 2. To note down any unusual pathological appearances, or abnormal deviations; although they may at the time appear to have no bearing on the question of poisoning. It is useful to bear in mind on these occasions, that the body is inspected, not merely to show that the person has died from poison, but to prove that he has *not* died from any *natural cause*. Medical practitioners commonly give their attention exclusively to the first point; while lawyers, who defend accused parties, very properly direct a most searching examination to the last-mentioned point, *i. e.* the healthy or unhealthy state of those organs which are essential to life, and with which the poison has not probably come in contact. The usual causes of *sudden death* have their seats commonly in the brain, the heart and its great vessels, or in the lungs. Marks of effusion of blood, congestion, inflammation, suppuration, or a diseased condition of the valves of the heart, should be sought for and accurately noted, whatever may be the condition of the abdominal viscera. It has also been recommended that an examination of the spinal marrow should be made. If the cause of death be obscure after the general examination of the body, there is good reason for inspecting the condition of this organ.

Exhumation of Bodies.—Sometimes the inspection of a body is required to be made long after interment. So long as the coffin remains entire, there may be the expectation of discovering certain kinds of mineral poison in the organs; but decomposition may have advanced so far as to destroy all pathological evidence. The inspection in such cases is commonly confined to the abdominal

viscera. The stomach is often found so thinned and collapsed, that the anterior and posterior walls appear to form only one coat. This organ should be removed with the duodenum, and ligatures should be applied to each. The liver and the spleen should also be removed, in order that they may, if necessary, be separately analyzed. If poison is not found in one or more of these parts, it is not likely that it will be discovered in the body. It has been recommended that a portion of earth immediately above and below the coffin should be removed for analysis, as it may contain arsenic; but this appears to me to be an unnecessary piece of refinement when the coffin is entire, or when the abdominal parietes still cover the viscera. If decomposition has so far advanced as to have led to an admixture of earth with the viscera, and the poison is found in minute quantity in the tissues only, the source of the poison may be regarded as doubtful. The body of a deceased person, when exhumed, should be identified by some friend or relative, in the presence of the medical examiner. In one case of murder by poison, the evidence almost failed, owing to this precaution not having been taken.

It is important that the viscera taken from a body which has been long in the grave should be sealed up immediately. They should not be allowed to come in contact with any metal, nor with any surface except that of clean glass, porcelain, or wood. It has been recommended that they should be washed with chloride of lime, or placed in alcohol; but this is decidedly improper: the use of any preservative chemical liquid would not only embarrass the future analysis, but would render a special examination of an unused portion of the liquid necessary, the identity of which would have to be unequivocally established. Preservation from air in clean glass vessels, with well-fitted corks, covered with skin, or, what is still better, sheet-caoutchouc, is all that is required in practice. There is no objection to the use of a small quantity of chloroform. The vapour of this liquid is diffused through the vessel and tends to retard putrefaction. The contents of a stomach, consisting of blood and mucus, have thus been preserved in an unchanged state for several months.

Identity of Substances.

It is necessary to observe, that all legal authorities rigorously insist upon proof being adduced of the *identity* of the vomited matters or other liquids taken from the body of a deceased person, when poisoning is suspected. Supposing that during the examination, the stomach and viscera are removed from the body, they should never be placed on any surface, or in any vessel, until we have first ascertained that the surface or vessel is perfectly *clean*. If this point be not attended to, it will be in the power of counsel for the defence to raise a doubt in the minds of the jury, whether the poisonous substance might not have been accidentally present in the vessel used. This may be regarded as a very remote presumption; but, nevertheless, it is upon technical objections of this kind that acquittals follow, in spite of the strongest presumptions of guilt. This is a question for which every medical witness should be prepared, whether he is giving his evidence at a coroner's inquest, or in a Court of Law. Many might feel disposed to regard matters of this kind as involving unnecessary nicety and care, but if they are neglected it is possible that a case may be at once stopped: so that the care subsequently bestowed upon a chemical analysis will be labour thrown away. Evidence of the presence of poison in the contents of a stomach was once rejected at a trial for murder, because they had been hastily thrown into a jar borrowed from a neighbouring grocer's shop; and it could not be satisfactorily proved that the jar was clean and entirely free from traces of poison (in which the grocer dealt) when used for this purpose. When the life of a

human being is at stake, as in a charge of murder by poisoning, the slightest doubt is always very properly interpreted in favour of the accused.

Not only must clean vessels be used for receiving any liquid destined for subsequent chemical analysis, but care must be taken that the *identity* of a substance is preserved, or the most correct analysis afterwards made will be inadmissible as evidence. The suspected substance, when once placed in the hands of a medical man, should never be let out of his sight or custody. It should be kept sealed under his private seal, and locked up while in his possession, in a closet to which no other person can have access. If he has once let the article out of his hands, and allowed it to pass through the hands of several other persons, then he complicates the evidence for the prosecution, by rendering it indispensable for these persons to state under what circumstances it was placed while in their possession. The exposure of a suspected substance on a table, or in a closet or room to which many have access, may be fatal to its identity; for the chemical evidence, so important in a criminal investigation, will probably be altogether rejected by the Court. A case was tried on the Norfolk circuit, in which an analysis of certain matters vomited by a person poisoned with arsenic, was not admitted as evidence against the prisoner, because the medical man had left them in the custody of two women; and these women had allowed the vessel containing the suspected liquid (which was proved to contain arsenic) to be exposed in a room open to the access of many persons. In another case, tried at the Old Bailey Sessions in 1835, the analysis of some suspected liquids was not allowed in evidence, because the practitioner, who lived in the country, and was unwilling to take the responsibility of analysing them, had sent them up to town by a carrier to be examined by a London chemist. If closely sealed by a private seal, and this is observed by the receiver to be unbroken, before he proceeds to an analysis, this mode of transmission will not probably be objected to. When any article (*e.g.* a stomach or other organ) is reserved for analysis, care should be taken to attach immediately to it, or to the vessel containing it, a parchment or wooden label, upon which is plainly written, in ink, the name of the deceased and the date of removal, including the day of the week and month. This is especially necessary when there are two or more articles for analysis. I have known the greatest inconvenience to result from the neglect of this simple precaution.

Preserving articles for analysis.—In removing viscera or liquids from the body, and reserving them for analysis, it is necessary to observe certain precautions. A clean vessel with a wide mouth should be selected; it should be only sufficiently large to hold the organ or liquid (the less air remaining in it the better); it should be secured by a closely-fitting clean cork, covered with fine skin or bladder. Another piece of skin should then be tied over the mouth, or, for this, sheet-caoutchouc or gutta percha may be substituted with advantage. It should lastly be covered with tinfoil, and a layer of white leather. In this way any loss by evaporation or decomposition is prevented, and the viscera may be preserved (in a cool place) for some time. If the mouth of the vessel be too wide for a cork, the other articles cannot be dispensed with. Paper only should not be used: I have known the appearances after death of the viscera of an infant, suspected to have died from poison, entirely destroyed by drying, from the evaporation which took place through the layers of paper with which the vessel in which they were contained, was covered. The practitioner should bear in mind that all these matters are likely to come out in evidence; and whatever is worth doing at all, is worth doing well. For reasons already stated, antiseptic chemical compounds should not be used. The addition of a small quantity of chloroform to the viscera will, without complicating the analysis, tend to preserve them.

The articles used for the preservation of viscera should be in all cases scrupulously examined. Some kinds of calico are dressed with arsenic and starch paste, and many kinds of wrapping-paper as well as wall-papers are strongly impregnated with this poison. An observation made by Mr. Aickin, of Belfast, shows that this is not an unnecessary caution. This gentleman was engaged in examining the body of a child, in order to determine the cause of death. The organs were healthy, and as no sufficient cause presented itself, he removed the stomach, with a view of making an analysis of its contents. He was suddenly called away; and, to preserve the stomach, he wrapped it in a piece of paper (used for papering rooms), placing it on the uncoloured side, and he locked it in a closet until the following day. Assisted by a friend, he then analysed the contents, and found a trace of morphia with a large quantity of arsenic. As the symptoms from which the child had suffered were not those of poisoning with arsenic, and there were no appearances of the action of this substance on the body, he came to the conclusion that there must be some extraneous cause to account for its presence. He examined a portion of the wall-paper in which the stomach had been wrapped, and then found that that part of it which was coloured yellow was tinted with sulphide of arsenic or orpiment! It was therefore evident, as orpiment contains white arsenic, that the stomach and its contents had imbibed a portion of the poison during the night. ('Lancet,' June 23, 1855, p. 632.) This satisfactorily accounted for the presence of arsenic, under circumstances which might have given rise to a false charge of murder. Nearly all wall-papers, having any tinge of green or golden yellow in them, contain arsenic, and this arsenic spreads by imbibition to other parts of the paper not so tinted. It would, of course, be proper to avoid in all cases the use of any wrapper having upon it mineral colours of any description. Mr. Aickin's case shows in a striking point of view the danger of trusting to chemical analysis alone. Unless we look to physiology and pathology, a most erroneous opinion may be expressed.

Arsenic is sometimes found mixed with oxide of iron in ochreous deposits or soils. It is thus occasionally present in the soil of cemeteries, but in an insoluble form. Even in the fur deposited in tea-kettles, in which there is generally some oxide of iron, arsenic has been found in an insoluble form. From about a pound and a half of the crust or fur of a vessel used for boiling water, Otto obtained well-marked arsenical deposits. Pöllnitz has detected in the fur of kettles—copper, lead, tin, and even antimony. Dr. Osborn, of Southampton, has confirmed Pöllnitz's conclusion, namely, that lead is present in an insoluble form in the deposits of kettles and boilers. ('Med. Times and Gaz.' Dec. 22, 1860, p. 608.) Otto discovered a much larger proportion of arsenic in the calcareous crust taken from a kitchen boiler. Ten ounces of this gave a deposit of arsenic in a glass tube, and several stains on porcelain. He thinks that, if a sufficient quantity is employed, arsenic will be found in the sediments of all spring and well-waters. ('Ausmittelung der Gifte,' 1856, p. 61.) I have found arsenic in the water of rivers used for the supply of towns, and have extracted a well-marked quantity from two ounces of the dried mud of the Thames, as well as from similar quantities of earth taken from three churchyards in the north of England. ('Guy's Hosp. Reports,' Oct. 1860. On Arsenic and Antimony.) These facts, if they prove anything, tend to show the extreme danger of placing reliance on minute chemical results in the absence of good physiological and pathological evidence.

The results of an analysis, in the shape of sublimates or precipitates, should be preserved as evidence, distinctly labelled in small glass tubes hermetically sealed. They can then, if asked for, be produced for examination at the inquest or trial.

On the use of Notes.—It has already been recommended, as a rule in these criminal investigations, that a practitioner should make notes of what he observes in regard to symptoms, appearances after death, and the results of a chemical analysis. His own observations should be kept distinct from information given to him by others. He may base his conclusions on the former, but not on the latter. From the common forms of law in this country, a person charged with the crime of poisoning may remain imprisoned, if at a distance from the metropolis, for some months before he is brought to trial. It is obvious, however clear the circumstances may at the time appear to a practitioner, that it will require more than ordinary powers of memory to retain, for so long a period, a distinct recollection of all the facts of a case. If he is unprovided with notes, and his memory is defective, then the case will turn in favour of the prisoner, for he will be the person to benefit by the neglect of the witness. In adopting the plan here recommended, such a result may be easily prevented. It may be remarked that the law relative to the admissibility of notes or memoranda in evidence is very strict, and, in trials for murder, is rigorously enforced by the judges. In order to render such notes or memoranda admissible, it is indispensably necessary that they should be taken by the witness at the time the observations are made, or as soon afterwards as practicable; and further, it must be remembered that a witness can refer to them only for the purpose of refreshing his memory.

Medico-legal Reports.—One of the duties of a medical jurist is to draw up a report of the results of his examination: 1, in regard to symptoms; 2, in regard to appearances after death; and, 3, in regard to the results of an analysis. With respect to the two first divisions of the report, I must refer the reader to the rules for investigating cases of poisoning (p. 202). It need hardly be observed that the time at which the person was first seen, and the circumstances under which the attendance of the practitioner was required, as well as the period of death, should be particularly stated. The hour, the day of the week, and the month, should be invariably mentioned. Some medical witnesses merely state the day of the week, without that of the month, or *vice versâ*. At a trial this sometimes creates great confusion, by rendering a reference to almanacs necessary. The words yesterday, next day, &c., should never be used. The facts which it will be necessary to enter in the report are specially stated under the heads of investigation (see p. 202). If these facts are not observed in the order there set down, their value as evidence of the cause of death or of the criminality or innocence of particular parties, will be entirely lost. In drawing up a report of symptoms and appearances after death, the facts should be in the first instance plainly and concisely stated *seriatim*, in language easily intelligible to non-professional persons. A reporter is not called upon to display his erudition, but to make himself understood. If technical terms are employed, their meaning should be stated in parentheses. When a subject is thoroughly understood, there can be no difficulty in rendering it in simple language; and when it is not well understood, the practitioner is not in a position to make any report. Magistrates, coroners, and barristers are very acute, and easily detect ignorance, even when it appears under the mask of erudition.

In recording facts, a reporter should not encumber his statements with opinions, inferences, or comments. The facts should be first stated and the conclusions should be reserved until the end of the report. The language in which conclusions are expressed, should be precise and clear. It must be remembered that these are intended to form a concise summary of the whole report, upon which the judgment of a magistrate, or the decision of a coroner's jury, will be ultimately based. They should be most strictly confined to the matters which are the subject of inquiry, and which have actually fallen

under the observation of the witness. Thus, they commonly refer to the following questions:—What was the cause of death? What are the medical circumstances which lead you to suppose that death was caused by poison? What are the circumstances which lead you to suppose that death was *not* caused by natural disease? Answers to one or all of these questions comprise, in general, all that a reporter is required to introduce into the conclusions of his report.

The reporter must remember that his conclusions are to be based only upon *medical* facts,—not upon moral circumstances, unless he is specially required to express his opinion with regard to them when they are of a medico-moral nature. Further, they must be founded only on what *he has himself seen or observed.* Any information derived from others, should not be made the basis of an opinion in a medico-legal report. It is scarcely necessary to remark that a conclusion based upon mere *probabilities* is of no value as evidence.

In drawing up a report on the *results of a chemical analysis*, the following rules should be borne in mind. A liquid or solid may be received for analysis. 1. When, and of whom, or how received? 2. In what state was it received—secured in any way, or exposed? 3. If more than one substance received, each to be separately and distinctly labelled; appearance of the vessel, its capacity, and the quantity of liquid (by measure) or solid (by weight) contained therein. 4. Where and when did you proceed to make the analysis, and where was the substance kept during the intermediate period? 5. Did any-one assist you, or did you make the analysis yourself? 6. Physical characters of the substance. 7. Processes and tests employed for determining whether it contained poison. All the steps of these processes need not be described;—a general outline of the analysis will suffice. The magistrate may thus satisfy himself by an appeal to others (if necessary) whether the analysis has or has not been properly made. 8. Supposing the substance to contain poison—is this in a pure state or mixed with any other body? 9. The strength of the poison, if an acid, or if it be in solution: in *all* cases the *quantity* of poison found, determined if possible by actual weighing. 10. Supposing no poison to be contained in it, what was the nature of the substance? Did it contain anything of a noxious nature, *i.e.* likely to injure health or destroy life? 11. Could the supposed poisonous substance exist naturally or be produced within the body? 12. Was it present in any of the liquids or solids employed in the chemical analysis? 13. Was it contained in any of the articles of food or medicine taken by the deceased? 14. Is its presence to be ascribed to the use of any mineral matter employed by injection after death for the preservation of the body of the deceased? 15. What quantity of poison was actually separated in the free or absorbed state? 16. How much of the substance found would, under the circumstances, be likely to destroy life?

There are few reports in which answers to many of these questions, although not formally put, will not be required; and unless the whole of them are borne in mind by the operator at the time an analysis is undertaken, those which are omitted can never receive an answer, however important to the ends of justice that answer may ultimately become.

IRRITANT POISONS.

CHAPTER 14.

SULPHURIC ACID OR OIL OF VITRIOL. SYMPTOMS—APPEARANCES AFTER DEATH—FATAL DOSE—PERIOD AT WHICH DEATH TAKES PLACE—MODE OF DETECTING THE POISON IN PURE AND MIXED LIQUIDS—IN ARTICLES OF CLOTHING.

Sulphuric Acid or Oil of Vitriol. Sulphate of Indigo.

Symptoms.—When this poison is swallowed in a concentrated form, the symptoms produced come on either *immediately*, or during the act of swallowing. There is violent burning pain, extending through the throat and gullet to the stomach, and the pain is often so severe that the body is bent. There is an escape of gaseous and frothy matter, followed by retching and vomiting, the latter accompanied by the discharge of shreds of tough mucus and of a liquid of a dark coffee-ground colour, mixed with blood. The mouth is excoriated, the lining membrane and surface of the tongue white, or resembling soaked parchment; in one instance the appearance of the mouth was as if it had been smeared with white paint. After a time, the membrane acquires a grey or brownish colour; the mouth is filled with a thick viscid substance consisting of saliva, mucus, and the corroded membrane; this renders speaking and swallowing difficult. If the poison has been administered by a spoon, or the phial containing it has been passed to the back of the throat, the mouth may escape the chemical action of the acid. A medical witness must bear this circumstance in mind when he is required to examine an infant suspected to have been poisoned by sulphuric acid. Around the lips and on the neck may be found spots of a brown colour from the spilling of the acid and its action on the skin. There is great difficulty of breathing, owing to the swelling and excoriation of the throat and larynx, and the countenance has, from this cause, a blueish or livid appearance; the least motion of the abdominal muscles is attended with increase of pain. These symptoms, although characteristic of the action of a corrosive liquid, have been sometimes mistaken for those of disease. ('Henke, Zeitschrift der S.A.' 1843, 2, 284.) The stomach is so irritable that whatever is swallowed is immediately ejected, and the vomiting is commonly violent and incessant. In a case reported by the late Dr. Geoghegan, the patient vomited for three or four hours. This symptom then ceased, and did not recur, although the woman did not die until thirty-four hours after the poison had been swallowed. ('Med. Gaz.' vol. 48, p. 328.) The matters *first* vomited generally contain the poison: they are acid, and if they fall on a limestone pavement there is effervescence; if on coloured articles of dress, the colour is sometimes altered to a red or yellow, or it is entirely discharged and the texture of the stuff destroyed; on a black cloth dress, the spots produced by the concentrated acid are reddish-brown, and remain moist for a considerable time. An attention to these circumstances may often lead to a suspicion of the real cause of the symptoms, when the facts are concealed. After a time there is exhaustion, accompanied by great weakness; the pulse is quick, small, and feeble; the skin cold, mottled, and covered with a clammy sweat. There is generally great thirst, with obstinate constipation of the bowels; should any evacuations take place, they are commonly either of a dark brown or leaden colour, in some instances almost black arising from an admixture of altered blood. There are sometimes con-

vulsive movements of the muscles, especially those of the face and lips. The countenance if not livid from obstructed respiration, is pale, expressive of great anxiety and intense suffering. The intellectual faculties are quite clear, and in the greater number of cases of acute poisoning by this acid, death takes place very suddenly in from eighteen to twenty-four hours after the poison has been taken.

Appearances after death.—The marked effects of this poison are not always observed in the stomach; they may be confined to the region of the throat and windpipe. In an inspection of the body, the whole course of the alimentary canal from the mouth downwards, should be examined; since in recent or acute cases it is in the throat and gullet that we generally obtain strong evidence of the action of a corrosive poison. The discovery of the usual marks of corrosion in these parts is always highly corroborative of the signs of poisoning found in the stomach. During the inspection, the examiner must not omit to notice any spots on the skin produced by the spilling of the acid: these are commonly of a dark brown colour, and are situated about the mouth, lips, and neck. The appearances met with in the body vary, according to whether death has taken place quickly or slowly. Supposing the case to have proved rapidly fatal, the membrane lining the mouth may be found white, softened, and corroded. The mucous membrane of the throat and gullet is commonly found corroded, having a brown-black or ash-grey colour, and dark-coloured blood is effused in patches beneath it. The corroded membrane of the gullet is occasionally disposed in longitudinal folds, portions of it being partly detached. The *stomach*, if not perforated, is collapsed and contracted. On laying it open, the contents are commonly found of a dark brown or black colour and of a tarry consistency, being formed in great part of mucus and altered blood. The contents may or may not be acid, according to the time the patient has survived, and the treatment which has been adopted. On removing them, the stomach may be seen traversed by black lines, or the whole of the mucous membrane may be corrugated and stained black or of a dark brown colour. This blackness is not entirely removed by washing. On stretching the stomach, traces of inflammation may be found between the folds, indicated by a dark crimson red colour. On forcibly removing the blackened membrane, the red colour indicative of inflammation may be seen in the parts beneath. Both the dark colour and marks of inflammation are sometimes partial, being confined to isolated portions or patches of the mucous membrane. When the stomach is perforated, the coats are softened, and the edge of the aperture is commonly black and irregular. In removing the stomach, the opening is liable to be made larger by the mere weight of the organ. The contents do not always escape; but when this happens, the surrounding parts are attacked by the poison. In a case which occurred at Guy's Hospital, the spleen, the liver, and the coats of the aorta, were found blackened and corroded by the acid, which had escaped through the perforation. In some rare cases the lining membrane of the aorta has been found strongly reddened. When a person has survived for eighteen or twenty hours, traces of corrosive and inflammatory action may be found in the small intestines. In one case the mucous membrane of the ileum was corroded. The interior of the windpipe, as well as of the bronchial tubes, has also presented marks of the local action of the acid. The acid has thus destroyed life without reaching the stomach. A remarkable instance in which the poison penetrated into and destroyed both lungs has been reported by Sir William Gull. (See 'Med. Gaz.' vol. 45, p. 1102.) It is important for a medical witness to bear in mind, that the mouth, throat, and gullet are not always found in the state above described. Dr. Ogle met with a case in which the membrane of the tongue was but slightly affected. The man had swallowed a large dose

of the acid and had died in nine hours. ('Med. Times and Gazette,' April 21, 1860.) Strange as it may appear, cases are recorded in which, notwithstanding the introduction of this poison into the stomach, the gullet has escaped its chemical action. Mr. Dickinson has reported a case of poisoning with sulphuric acid, in which there was no corrosion of the mouth and throat. The patient, a female, æt. 52, recovered in about five months. The stomach had probably sustained injury, as the most urgent symptoms were constant vomiting after taking food, and obstinate constipation. The quantity of acid swallowed was half an ounce, mixed with half an ounce of water. The patient felt *immediately* a burning sensation at the pit of the stomach. ('Lancet,' Nov. 26, 1853, p. 502.) The acid had here evidently lost its corrosive power by dilution. Cases of recovery are very rare. A woman took into her mouth a quantity of the acid by mistake; she spat it out immediately. Magnesia was given to her, and two hours afterwards she was suffering from intense burning pain in the throat, gullet, and stomach. Her lips were swollen and blistered; the lining of the mouth was whitish, but not excoriated; the soft palate and uvula were congested and partly destroyed. Olive oil and bicarbonate of soda were given at intervals. At a later period, there was vomiting of an opaque milky-looking substance. Two days after there was some difficulty of breathing, but this symptom subsided, and the patient was discharged apparently well. ('Lancet,' 1871, vol. 2, p. 540.) When the acid has been taken in a still more *diluted* state, the marks of inflammation on the mucous membrane are less decided, and the blackening is not so considerable. Nevertheless, the acid, unless too much diluted, acts upon and darkens the blood in the vessels, as well as that contained in the stomach, although it may not blacken the mucous membrane or the contents.

Dr. Walker, of Inverness, met with a case in which a man, æt. 30, swallowed fifteen drachms and a half of sulphuric acid (sp. gr. 1·842), and died twenty-five hours afterwards. Half an hour after taking the poison he resembled a patient in the collapsed stage of cholera. The inside of the lips, as well as the tongue and throat, were swollen, and had the appearance of being smeared with thin arrow-root. He suffered severe pain, but did not vomit until *three-quarters of an hour* had elapsed: the vomiting appeared to be then excited by the liquid which had been given to him. The vomited matters were dark, bloody, and viscid. The patient was sensible up to the time of his death. An inspection revealed the usual appearances. The mucous membrane of the stomach was destroyed, and the whole surface was darkened. The greatest amount of injury was at the pyloric end, where three small perforations were found. The orifice of the pylorus was swollen, constricted, and hardened; it was so contracted as to admit only a silver probe. The duodenum had also suffered. The first two inches of the arch of the aorta were much inflamed. There were no traces of the acid in the stomach; there was a slight trace in the duodenum; a trace in the serous fluid at the base of the brain; but the largest quantity was found in the blood contained in the heart. ('Edin. Monthly Jour.' June 1850, p. 538.) This case is remarkable in the fact that vomiting was not immediate; that there were no spots on the outside of the face; that the poison was swallowed in large quantity on an empty stomach; and there was free voluntary exertion, as, twenty hours after he had taken the poison, the man got out of bed and sat on a night-stool. The late Dr. Geoghegan has published in the London 'Medical Gazette,' vol. 48, p. 328, a full account of the symptoms and appearances after death in a well-marked case of poisoning by sulphuric acid, as well as a process for detecting this poison when absorbed.

Quantity required to destroy life.—The dangerous effects of the acid appear to arise rather from its degree of concentration, than from the absolute quan-

tity taken. The quantity actually required to prove fatal must depend on many circumstances. If the stomach is full when the poison is swallowed, the action of the acid may be spent on the food and not on the stomach; and a larger quantity might then be taken than would suffice to destroy life if the organ were empty. The smallest quantity which is described as having proved fatal was in the following case:—Half a teaspoonful of concentrated sulphuric acid was given to a child about a year old by mistake for castor oil. The usual symptoms came on, with great disturbance of breathing, and the child died in twenty-four hours. The quantity here taken could not have exceeded *forty drops*. ('Med. Gaz.' vol. 29, p. 147.) It is, however, doubtful whether this small quantity would have proved fatal to an adult. The smallest fatal dose which Sir R. Christison states he has found recorded, is *one drachm*; it was taken by mistake by a stout young man, and killed him in seven days. (Op. cit. 162.) Even when diluted, it will destroy life rapidly. A man swallowed, on an empty stomach, six drachms of the strongest acid diluted with eighteen drachms of water. He suffered from the usual symptoms, and died in two hours and a half. ('Med. Times and Gaz.' 1863, vol. 1, p. 183.)

Period at which death takes place.—It has been already stated, that the average period at which death takes place in cases of acute poisoning by sulphuric acid, is from eighteen to twenty-four hours. When the stomach is perforated by the acid, it commonly proves more speedily fatal. In one instance, reported by Dr. Sinclair, a child about four years old died in four hours: the stomach was found perforated. When the poison acts upon the windpipe, death may be a still more speedy consequence, from suffocation; and, owing to this, it appears to be more rapidly fatal to children than adults. Dr. Craigie mentions a case in which three ounces of concentrated sulphuric acid destroyed life in three hours and a half. Remer met with an instance in which death took place in *two hours*. A case is reported by Mr. Watson, in which a woman swallowed two ounces of a strong acid. She died in *half an hour*, but it appears that a quarter of an hour before death she had made a deep wound in her throat, which gave rise to great bleeding. The stomach was found extensively perforated: but it is highly probable that the wound accelerated death in this case. The shortest case recorded, occurred to M. Rapp. A man, æt. 50, swallowed three ounces and a half of concentrated sulphuric acid. He died in *three-quarters of an hour*. ('Gazette Médicale,' Dec. 28, 1850.) On the other hand, there are numerous instances reported in which the poison proved fatal from secondary causes, at periods varying from one week to several months. Fifty-three deaths from sulphuric acid in England and Wales were recorded in a period of four years, 1863–7.

Chemical Analysis.—This acid may be met with either concentrated or diluted; and a medical jurist may have to examine it under three conditions:—1. In its simple state. 2. When mixed with organic matters, as with liquid articles of food, or in the contents of the stomach. 3. On solid organic substances, as where the acid has been thrown or spilled on articles of dress or clothing.

In the simple state. If *concentrated*, it possesses these properties: 1. Wood, sugar, or other organic matter plunged into it, is speedily carbonized or charred, either with or without the application of heat. 2. When boiled with wood, copper-cuttings, or mercury, it evolves fumes of sulphurous acid; this is immediately known by the odour, as well as by the acid vapour first rendering blue, and then bleaching starch-paper dipped in a solution of iodic acid. 3. When mixed with an equal bulk of water, great heat is evolved—nearly 200° F., in a cold vessel.

The diluted Acid. For the acid in a diluted state, but one test may be

applied, either the *nitrate of baryta* or the *chloride of barium.* Having ascertained by test-paper that the liquid is acid, we add to a portion of it a few drops of nitric acid, and then a solution of the barium salt. If sulphuric acid is present, a dense white precipitate of sulphate of baryta will fall down: this is insoluble in all acids and alkalies. The precipitate is collected, dried, and mixed with five parts of charcoal in powder. This mixture is placed in a small platinum crucible, which should be closely covered, and then heated to full redness for five minutes. If the precipitate is a sulphate, it will be converted into a sulphide. In order to prove this:—1. A portion of the chemical mixture when cooled may be mixed with water, well stirred, and filtered. A pale yellowish liquid will be obtained, having an alkaline reaction, and giving a brown or black precipitate with a solution of acetate of lead. 2. If in small quantity, the mixture may be placed at once on glazed card (coated with carbonate of lead) and wetted, when a stain of sulphide of lead will be produced. 3. The powder may be heated with strong hydrochloric acid, when sulphuretted hydrogen will be copiously evolved, known by its smell and other properties. If the quantity of precipitated sulphate is very small, it may be mixed with one-third of its weight of cyanide of potassium and heated in a reduction-tube to full redness. This residue, placed on glazed card, wetted, gives the reaction indicative of the presence of a sulphide, proving that the original precipitate was a sulphate, and that sulphuric acid was present in the liquid submitted to analysis.

Diluted sulphuric acid does not carbonize organic substances which are immersed in it. The application of heat will only effect carbonization when the water of the acid is entirely evaporated. Thus, paper or linen, wetted with the diluted acid, becomes charred when dried and heated. This may serve as one method of identification in the absence of tests.

In liquids containing organic matter. If sulphuric acid is mixed with such liquids as porter, coffee, or tea, the process for its detection is substantially the same, the liquid being first rendered clear by filtration. The precipitated sulphate of baryta, if mixed with organic matter, may be purified by boiling it in strong nitric acid; but this is not commonly necessary, as the reduction of the dried precipitate may be equally well performed with the impure, as with the pure sulphate. Some liquids, such as vinegar, beer, and most wines, generally contain a soluble sulphate and have an acid reaction, but the acid is in very small proportion: therefore, if the precipitate is large, there can be no doubt, *cæteris paribus*, that free sulphuric acid has been added to them. Should the liquid be thick and viscid like gruel, it may be diluted with water, and then boiled with the addition of a little acetic acid. For the action of the barytic test, it is not necessary that the liquid should be absolutely clear, provided it is not so thick as to interfere mechanically with the subsidence of the precipitate. So far with regard to liquids administered, or of which the administration has been attempted. A similar process may be applied to the examination of matters *vomited* and of the *contents of the stomach*, care being taken to separate the insoluble parts by filtration, before adding the test. The coats of the stomach should be cut up and then boiled in distilled water for some time for the perfect extraction of the acid. The decoction filtered and concentrated by evaporation may then yield evidence of its presence.

When the acid is mixed with milk, decomposed blood and mucus, or other substances, rendering it thick and viscid, it may be readily separated by dialysis; a process which is applicable to the other acid poisons, such as the nitric, hydrochloric, and oxalic. A portion of the acid viscid liquid should be placed in a test tube, about five inches long and one inch in diameter, open

at both ends, the neck being securely covered with a layer of thin bladder. The tube is then immersed, mouth downwards, in a beaker containing distilled water. After some hours the acid will pass through the membrane, and may be detected in the water. This process may be employed as a trial test of the contents of the stomach when they have a strong acid reaction. In thus testing for sulphuric acid it must be remembered that a sulphate, like Epsom salts, may be present in the liquid, and an innocent acid like vinegar or lemon-juice may give the acid reaction. To remove any fallacy on this ground, a portion of the liquid tested should be evaporated, and the residue incinerated, when the sulphate, if present, will be obtained.

Fig. 4.

Beaker and tube for the dialysis of liquid poisons.

It is a medico-legal fact of considerable importance, that the contents of a stomach in a case of poisoning by sulphuric acid, are sometimes entirely free from any traces of this poison, even when it has been swallowed in large quantity. The acid is not commonly found when the person has been under treatment, when there has been considerable vomiting, aided by the drinking of water or other simple liquids, or when he has survived several days. If the case has been under treatment, the acid is either wholly absent or neutralized by antidotes. A girl swallowed four or five ounces of diluted vitriol, and died in eighteen hours. No portion of the acid could be detected in the stomach; but she had vomited considerably, and the acid was easily proved to exist in the vomited matters, by examining a portion of the sheet of a bed which had become wetted by them. In another case, nearly two ounces of the concentrated acid were swallowed; the patient died in twenty-five hours; the stomach was extensively acted on, and yet no trace of the acid could be discovered in the contents. The liquidity of the poison, and the facility with which it becomes mixed with other liquids and ejected by vomiting, will readily furnish an explanation of this fact. In many cases of poisoning by sulphuric acid, therefore, a medical witness must be prepared to find that chemical analysis will furnish only negative results. This, however, is not inconsistent with death having taken place from the poison. The facts are so conclusive on this point, that I should not have thought it necessary to add to the evidence accumulated on the subject, but that an erroneous statement has been put prominently before the public that no person can die from poison, except the poison be found in the body. Casper has dealt with this question. He relates three cases of poisoning by sulphuric acid, which occurred to himself, one which proved fatal in eight days, a second in five days, and a third in three days. In not one instance could a trace of the poison be found. (Handb. der Ger. Med. i. vol. 1, pp. 421, 429.) In the second case two tablespoonfuls were swallowed by a girl. The analysis revealed merely the accidental presence of a fractional part of a grain of alkaline sulphate in the stomach and bowels. Thus there was an entire failure of proof from chemistry, while the facts of the case, and the appearances in the body, established conclusively that death had really been caused by sulphuric acid. In one instance, in which death took place on the eleventh day, I found no trace of sulphuric acid in the body. If the stomach should be perforated, the contents will be found in the abdomen, or perhaps in the lower part of the cavity of the pelvis: they may then be collected, boiled with distilled water, and the solution examined for the acid by the process already described. If the contents of the stomach are highly putrefied, the sulphuric acid may be found combined with ammonia.

On solid organic substances. It sometimes happens in cases of poisoning by sulphuric acid that it is spilled upon articles of clothing, such as cloth or linen,

and here a medical jurist may succeed in detecting it, when every other source of chemical evidence fails. Again, sulphuric acid is often used for the purpose of seriously injuring a party, as by throwing it on the person, an offence which, when accompanied with bodily injury, renders the offender liable to a severe punishment. On such occasions, proof of the corrosive nature of the liquid is required; and this is easily obtained by a chemical examination of a part of the dress. A case of this kind was tried at the Liverpool Winter Assizes, 1866 (*Reg.* v. *Goff*). The injury appears to have been of a superficial kind. The jury found the prisoner guilty of throwing the corrosive fluid, but with no intent to injure. This was tantamount to an acquittal. Injury to the clothes only does not constitute the crime. There must be injury to the person. There have been many instances of vitriol-throwing for the sake of damaging the dress. The process of analysis is very simple. The spot, unless it has been washed, strongly reddens litmus paper pressed upon it. The stained cloth should be digested in a small quantity of distilled water at a gentle heat, whereby a brownish-coloured liquid may be obtained on filtration. If sulphuric acid is present, the liquid will have an acid reaction, and produce the usual effects with the barytic test. Old stains are known by the complete destruction of the organic fibre: fresh stains by their dampness. The acid remains fixed in the stuff. I have thus detected sulphuric acid in clothing after the long period of twenty-seven years. The detection of spots of this acid on articles of dress, has in some cases served to supply the place of direct evidence from a chemical analysis of the stomach; and in other instances it has aided justice in fixing on an accused person the act of administration.

The importance of analysis applied to articles of clothing was made evident in *Reg.* v. *Brown* (Bury St. Edmunds, Lent Assizes, 1864). The deceased, aged three years, was an illegitimate child of the prisoner. It was living with the prisoner's father and mother. On the day of its death, the prisoner came to see the child and was with it alone in a bedroom: in *five minutes* after she had left the room, no other person being present, the child was heard to be sick, and it was found to be suffering from the effects of some corrosive acid. The child died in about nine or ten hours, and the symptoms during life, when it was seen by a medical man, as well as the appearances in the body after death, were clearly those of poisoning by oil of vitriol. Mr. Image detected the acid in vomited matter on the shirt of the child, and on a dress worn by the mother on the occasion of her visit. It was further proved that a bottle of vitriol, kept in a closet of the house where she was servant, was missing. In spite of these strong facts in proof of administration, the jury, under the charge of the judge, Cockburn, C. J., acquitted the prisoner. It was somewhat remarkable that the child did not scream from pain during the act of swallowing, and that attention should not have been called to its condition until after the lapse of five minutes. Still the facts appeared to point to the prisoner only, as the person who administered the poison.

Sulphate of Indigo.

Several cases of accidental poisoning by this liquid have occurred. As the compound is nothing more than a solution of indigo in strong sulphuric acid, the symptoms and appearances after death are similar to those which have been already described. This kind of poisoning may be suspected when, together with these symptoms, the membrane of the mouth has a blue or blue-black colour. The vomited matters, as well as the fæces, are at first of a deep blue-black tint; afterwards green; and it was observed in two instances that the urine, voided by the patients, had a blue tinge.

It is proper to notice, that as indigo is one of the substances now directed

to be mixed with arsenic when this poison is sold in small quantities, the detection of this colouring principle in the mouth and vomited matters will not necessarily show that it has been taken in the form of sulphate.

Analysis.—This solution is of a dark blue colour, and strongly acid. Sulphuric acid is detected in it by the methods above described. The blue colour is discharged by chlorine, or when a portion previously diluted has been boiled with nitric acid.

CHAPTER 15.

POISONING BY NITRIC ACID OR AQUA FORTIS—APPEARANCES AFTER DEATH—PROCESSES FOR DETECTING THE POISON IN LIQUIDS CONTAINING ORGANIC MATTER—POISONING BY HYDROCHLORIC ACID.

NITRIC ACID is popularly known under the name of Aqua Fortis, or Red spirit of nitre. According to Tartra, it seems to have been first used as a poison about the middle of the fifteenth century. Although it is perhaps much more used in the arts than oil of vitriol, cases of poisoning by it are by no means common. In four years, 1863–7, sixteen deaths from this acid were recorded.

Symptoms.—When Nitric acid is taken in a concentrated state, the symptoms, on the whole, bear a close resemblance to those produced by sulphuric acid. They come on *immediately*, and the swallowing of the acid is accompanied by intense burning pain in the throat and gullet, extending downwards to the stomach: there are gaseous eructations, from the chemical action of the poison, swelling of the abdomen, violent vomiting of liquid or solid matters, mixed with altered blood of a dark brown colour, and shreds of yellowish-coloured mucus, having a strong acid reaction. The abdomen is generally exquisitely tender: but in one well-marked case of poisoning by the acid, the pain was chiefly confined to the throat: probably the poison had not reached the stomach. The mucous membrane of the mouth is commonly soft and white, after a time becoming yellow, or even brown; the teeth are also white, and the enamel is partially destroyed by the chemical action of the acid. There is great difficulty of speaking and swallowing, the mouth being filled with viscid mucus: the power of swallowing is, indeed, sometimes entirely lost. On opening the mouth, the tongue may be found swollen, and cf a citron colour; the tonsils are also swollen and enlarged. The difficulty of breathing is occasionally such as to render tracheotomy necessary, especially in young persons. (See case by Mr. Arnott, 'Med. Gaz.' vol. 12, p. 220.) As the symptoms progress, the pulse becomes small, frequent, and irregular—the surface of the body extremely cold, and there are frequent rigors (shivering). The administration of remedies, even the swallowing of the smallest quantity of liquid, increases the severity of the pain, occasions vomiting, and gives rise to a feeling of laceration or corrosion. (Tartra, 144.) There is obstinate constipation. Death takes place in from eighteen to twenty-four hours, and is sometimes preceded by a kind of stupor, from which the patient is easily roused. The intellectual faculties commonly remain clear until the last. In one instance the patient was insensible, but she ultimately recovered. Death may be occasioned by the action of this acid on the larynx, as in the case of sulphuric acid. Should the patient survive the first effects of the poison, the mucous membrane of the throat and gullet may be ejected, either in

irregular masses, or in the form of a complete cylinder. There is great irritability of the stomach, with pain on taking food, frequent vomiting and ultimate destruction of the powers of digestion: the patient becomes slowly emaciated, and dies, sometimes after many months, from starvation or exhaustion. A man swallowed nitric acid in beer: he recovered from the first symptoms, but died six months afterwards, evidently from the injury caused by the poison to the mucous lining of the stomach. He suffered from pain and from such irritability in this organ, that neither solids nor fluids could be retained. ('Lancet,' Nov. 24, 1860, p. 510.)

The *vapour* of this acid is destructive to life. In March 1854, *Mr. Haywood*, a chemist of Sheffield, lost his life under the following circumstances:—He was pouring a mixture of nitric and sulphuric acids from a carboy containing about sixty pounds, when by some accident the vessel was broken. For a few minutes he inhaled the fumes of the mixed acids, but it does not appear that any of the liquid fell over him. Three hours after the accident, he was sitting up and appeared to be in moderately good health. He was then seen by a medical man, and complained merely of some cuts about his hands. He coughed violently. In three hours more there was difficulty of breathing, with increase of the cough. There was a sense of tightness at the lower part of the throat, and the pulse was hard. At times he said he could scarcely breathe. He died eleven hours after the accident. On inspection, there was congestion of the windpipe and bronchial tubes, with effusion of blood in the latter. The heart was flaccid, and contained but little blood; and the lining membrane of the heart and aorta was inflamed. The blood gave a slightly acid reaction with test paper. The windpipe was not examined. It is very probable that the seat of mischief was in this organ, and that the deceased died from inflammatory effusion and a swelling of the parts about the opening of the windpipe. ('Lancet,' April 15, 1854, p. 430.) A similar accident occured to *Mr. Stewart* and one of the janitors of an educational institution in Edinburgh, in March 1863. A jar of nitric acid, which he was carrying, fell on the floor and was broken. He and the janitor, instead of withdrawing from the spot, wiped the floor, and attempted to save some of the acid. They thus inhaled the fumes which were immediately diffused. Mr. Stewart returned home unconscious of the mischief which had been done. After an hour or two, difficulty of breathing came on, and in spite of every medical effort to save his life, he died in ten hours after the accident. The janitor suffered from similar symptoms, and died the day following. ('Chemical News,' March 14, 1863, p. 132.) It is probable that in these cases there was great bronchial effusion, leading to the entire obstruction of respiration. The fumes of nitrous acid vapour, which is generally associated with nitric acid, are of a very deadly kind. In the manufacture of gun-cotton acid vapours are evolved, which, if respired, although they may produce no immediate ill effects, are liable to cause pneumonia and death. On one occasion, in preparing gun-cotton, I accidentally inhaled the vapour, and suffered from severe constriction of the throat, tightness in the chest, and cough for more than a week.

Appearances after death.—Supposing death to have taken place rapidly from the liquid acid, the following appearances may be met with. The skin of the mouth and lips will present various shades of colour, from an orange-yellow to a brown; it appears like the skin after a blister or burn, and is easily detached from the subjacent parts. Yellow spots produced by the spilling of the acid may be found about the hands and neck. A yellow frothy liquid escapes from the nose and mouth; and the abdomen is often much distended. The membrane lining the mouth is sometimes white, at others of a citron colour; the teeth are white, but present a yellowish colour about the coronæ. The pharynx and larynx are much inflamed; the latter is

sometimes œdematous. The lining membrane of the gullet is softened, and of a yellow or brown colour, easily detached, often in long folds. The trachea is more vascular than usual, and the lungs are congested. The most strongly marked changes are, however, seen in the stomach. When not perforated, this organ may be found distended with gas, its mucous membrane partially inflamed, and covered by patches of a yellow, brown, or green colour, or it may be even black. This green colour is due to the action of the acid on the colouring matter of the bile; but it must be remembered that a morbid state of the bile itself may give a similar appearance to the mucous membrane in many cases of death from natural disease. There is occasionally inflammation of the peritoneum, and the stomach is glued to the surrounding organs. Its coats may be so much softened, as to break down under the slightest pressure. In the duodenum similar changes are found; but in some cases the small intestines have presented no other appearance than that of slight redness. It might be supposed that the stomach would be in general perforated by this corrosive liquid; but perforation has not been often observed. Tartra met with only two instances, and in one of these the person survived twenty, and in the other thirty hours. In giving this poison to rabbits, I have not found the stomach perforated, although the acid had evidently reached that organ, as its coats were stained of a deep yellow colour. In these experiments the non-perforation appeared to be due to the protective influence of the food with which the stomach was distended. In the few cases that are reported in English journals, it would appear that the stomach has not been perforated: the poison had been swallowed soon after a meal, and its coats had thus escaped the corrosive action of the acid. In a case which proved fatal after the long period of six months, there was, at the intestinal end of the stomach, a distinct cicatrix with puckering and hardening of the surrounding mucous membrane, causing a slight contraction of the pyloric orifice. The only other appearance consisted in some dark longitudinal lines on the posterior surface of the lining membrane of the gullet. This had probably been caused by the acid. ('Lancet,' Nov. 24, 1860, p. 510.)

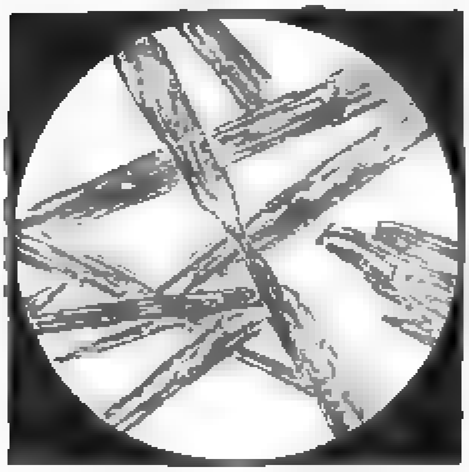
Quantity required to destroy life.—The *smallest* quantity of this acid which I find reported to have destroyed life, is about *two drachms.* It was in the case of a boy, aged thirteen: he died in about thirty-six hours. But less than this quantity, even one drachm, would doubtless suffice to kill a child, and, under certain circumstances, an adult; for the fatal result depends on the extent of the mischief produced by this corrosive poison in the windpipe, gullet, and stomach. What is the largest dose of concentrated acid, from the effects of which a person has recovered, it is difficult to say; since in most of the cases of recovery mentioned by authors, the quantity of the poison taken was unknown. A case of recovery from about half an ounce of the strong acid mixed with the diluted acid, is reported in the 'Lancet,' 1870, vol. I, p. 549. The patient was a man, æt. 21. He had the usual symptoms, with the exception that there was no yellowing of the teeth nor corrosion of the mouth. The vomited matters were bloody and of a dark colour. He suffered from stricture of the œsophagus, and this remained when he left the hospital about fifteen weeks after his admission.

Period at which death takes place.—Sobernheim relates a case of poisoning by nitric acid, which proved fatal in *one hour and three quarters.* (Op. cit. 402.) This I believe to be the most rapidly fatal instance on record, where the acid acted as a poison. The usual well-marked effects were found in the gullet, stomach, and small intestines. In infants, however, life may be destroyed by this poison in a few minutes, should it happen to effect the larynx. The longest case is, perhaps, that recorded by Tartra, where a woman perished from exhaustion, produced by the secondary effects of the poison, *eight months* after having swallowed it.

Chemical Analysis.—In the simple state. This acid may be met with either concentrated or diluted. The *concentrated acid* varies in colour from a deep orange red to a light straw yellow. It may be recognized, 1. By evolving acid fumes when exposed to the air or when heated. 2. By its staining organic matter yellow or brown, the colour being heightened and turned to a reddish tint by contact with caustic alkalies. 3. When mixed with a few copper cuttings, it is rapidly decomposed, a deep red acid vapour is given off, and a greenish-coloured solution of nitrate of copper is formed. Tin or mercury may be substituted for copper in this experiment. 4. The addition of leaf-gold and a few drops of hydrochloric acid. On warming the mixture, if nitric acid is present the gold is dissolved. Common aqua fortis (nitric acid) sometimes contains as impurity, a sufficiency of hydrochloric acid to dissolve leaf-gold by heat. *In the diluted state.* This acid is not precipitated like the sulphuric by any common reagent, since all its alkaline combinations are soluble in water. 1. The liquid has a highly acid reaction, and on boiling it with some copper turnings, red fumes of nitrous acid vapour are given off, unless the proportion of water is very great. At the same time the liquid acquires a blue colour. 2. A streak made on white paper with the diluted acid does not carbonize it when heated; but a scarcely visible yellow stain is left. 3. The liquid is not precipitated by a salt of barium or of silver. The two last experiments give merely negative results: they serve to show that the sulphuric and hydrochloric acids are absent.

In order to detect nitric acid, the liquid should be carefully neutralized by a solution of potash, and then evaporated slowly to obtain crystals. If the liquid contain nitric acid, these crystals will possess the following characters: 1. They appear in the form of lengthened fluted prisms, which neither effloresce nor deliquesce on exposure. One drop of the solution, evaporated spontaneously on glass, will suffice to yield distinct and well-formed prismatic crystals. This character distinguishes the *nitrate of potash* from a large number of salts. 2. When moistened with strong sulphuric acid, the powdered crystals slowly evolve a colourless acid vapour. By this test the nitrate is known from every other deflagrating salt. 3. A portion of the powdered crystals should be placed in a small tube and mixed with their bulk of fine *copper* filings. The mass is then to be moistened with water, and a few drops of strong *sulphuric acid* added. Either with or without the application of a gentle heat, orange-red fumes of nitrous acid are evolved, recognizable by their colour, odour, and reaction, and by their setting free iodine on starch-paper wetted with a solution of iodide of potassium. A small crystal of green sulphate of iron may be substituted for the copper. This acquires a pink or black colour, and on warming the mixture orange-red fumes escape. The suspected nitrate should be free from any alkaline chloride, and only a small reduction tube should be used when the quantity of the nitrate is small. If the nitrate is mixed with chloride, the following process will be found preferable. 4. We add to the powdered crystals a small portion of leaf-gold and strong hydrochloric acid; then boil for a few minutes. The gold will either wholly or entirely disappear if nitric acid or a nitrate is present. Its partial solution will be indicated by a dark brown or purple colour on the addition of chloride of tin to the liquid after boiling.

Fig. 5.



Crystals of Nitrate of Potash, magnified 30 diameters.

In liquids containing organic matter.—Nitric acid may be administered in

such liquids as tea, vinegar, or beer. In this case, besides the acid reaction, there will be a peculiar smell produced by the strong acid, when mixed with substances of an organic nature. The application of the usual tests may be here counteracted: thus, unless the quantity of nitric acid in the liquid is rather large, the orange-red fumes of nitrous acid are not evolved on boiling it with copper cuttings. The action on leaf-gold will enable the chemist to detect nitric acid in coffee, tea, and similar organic liquids, even when the proportion of acid is small. Boil a fragment of leaf-gold in pure hydrochloric acid, and add while boiling a few drops of the suspected organic liquid to the mixture. If the acid is present the gold will be dissolved. When the acid liquid is thick and turbid, a portion of it should be placed in a tube and submitted to the process of dialysis (see p. 215). Vomited matters, as well as the contents and coats of the stomach (cut up), should be boiled in water, and filtered. If not cleared by filtration, they may be submitted to dialysis, and the acid water obtained neutralized by potash, and concentrated. If by filtration we succeed in procuring a clear acid liquid, the colour is of no importance. The liquid should be carefully neutralized with a solution of pure potash, and concentrated by evaporation. Drops of this may be placed on a slide, and the crystals microscopically examined and compared with those of nitre. Paper dipped into the concentrated liquid and dried burns with deflagration like touch-paper.

The crystals obtained by evaporating the neutralized liquid are generally coloured with organic matter, but they fuse into a white mass when heated in a platinum capsule. The pure nitre thus obtained may be tested as above described. The organic matter in the crystals does not in any way interfere with the results of the copper and gold tests.

When either the nitric acid, or the nitrate into which it has been converted, is mixed with common salt, the copper test cannot be employed. The gold test will in such a case furnish the best evidence. Hydrochloric acid with a small portion of leaf-gold may be added to the dried residue, and the mixture boiled. If nitric acid or a nitrate is present, even in minute proportion, some portion of the gold will be dissolved, a fact demonstrable by the addition of chloride of tin.

Nitric acid may be detected in *stains on clothing*, if recent, by simply boiling the stained cloth in water. An acid liquid will be obtained, unless the stains are of old date or the stuff has been washed. This liquid, when concentrated, may be dealt with in the manner already described. The stains from this acid on black and blue cloth are of a yellow or brownish-yellow colour. When long exposed they become dry, but the cloth is easily torn. A simple method of detecting the acid is to boil at once a piece of the stained cloth with a fragment of leaf-gold and hydrochloric acid. If nitric acid is present in the stain, a portion of the gold will be dissolved.

Hydrochloric Acid. Muriatic Acid.

This acid, which is also called Muriatic acid, and is popularly known under the name of Spirit of salt, is but seldom taken as a poison. In four years, 1863–7, it was the cause of eight deaths. In the few cases which have been hitherto observed, the *symptoms* and *appearances* have been similar to those caused by nitric acid. The following case of poisoning by this acid occurred in King's College Hospital, in May 1859. A woman, æt. 63, swallowed *half an ounce* of concentrated hydrochloric acid. She was received into the hospital in three-quarters of an hour. The prominent symptoms were burning pain in the throat and stomach, feeble pulse, cold and clammy skin, retching and vomiting of a brown matter streaked with blood and con-

taining shreds of membrane. There was great exhaustion. The throat became swollen, the patient lost the power of swallowing, and died in eighteen hours. She retained her senses until the last. The *appearances* in the body were as follows: the mucous membrane of the mouth and throat was white, softened, and destroyed in many places by the corrosive action of the acid. The membrane of the gullet was red and inflamed. The back part of the stomach near the pylorus was black, stripped of its mucous membrane (which was generally softened), and marked with black lines. It was not perforated. ('Lancet,' July 16, 1859, p. 59.) In this case the smallest quantity of hydrochloric acid was taken which has as yet been known to prove fatal. I have elsewhere related a case of poisoning by this acid ('Guy's Hosp. Rep.' Oct. 1850, p. 211); and for other cases in which an ounce was taken and the persons recovered, see 'Lancet,' July 27, 1850, p. 113, and the 'Medical Gazette,' Dec. 28, 1849. Dr. Otto has reported a fatal case in a child in 'Horn's Vierteljahrsschrift,' 1865, vol. 1, p. 361. For a more detailed account of poisoning by this acid, see 'On Poisons,' second edition, p. 289. It is not often that muriatic acid is administered with criminal intent. A trial took place at the Taunton Winter Assizes 1866 (*Reg.* v. *Somers*), in which a girl of twelve years of age was charged with administering this acid to her mistress in beer, with intent to murder her. Some of the acid had been purchased for domestic use, and the prisoner had been cautioned not to touch it as it was poisonous. On tasting the beer prosecutrix perceived an unpleasant taste, and had a burning sensation in her throat. On analysis, the beer was found to contain muriatic acid. Life was not endangered, and no grievous bodily harm was done. The prisoner was convicted of a misdemeanour under the new statute, of administering poison with intent to injure, aggrieve, and annoy.

Chemical Analysis.—In a *concentrated* state, hydrochloric acid evolves copious fumes. The pure acid is nearly colourless: the commercial acid is of a lemon-yellow colour, and frequently contains iron, arsenic, common salt, and other impurities. When boiled with a small quantity of peroxide of manganese, chlorine is evolved. It does not dissolve leaf-gold until a few drops of nitric acid have been added to it, and the mixture is heated. In the *diluted* state, these properties are lost. It may then be recognized by the dense white precipitate which it gives when a solution of nitrate of silver is added to it. This precipitate is insoluble in nitric acid, but soluble in ammonia: it acquires a purple and black colour if exposed to light, and when heated it melts without decomposition, forming a yellowish-coloured substance on cooling. If the acid is contained in organic liquids in moderate quantity, it admits of separation by distillation to dryness. In this case any chlorides present are left in the retort. It may also be procured in a pure state for testing by dialysis. See page 215.

Hydrochloric acid, in small quantity, as well as alkaline chlorides, are natural constituents of the fluids of the stomach and bowels. The presence of local chemical changes in the throat and stomach, would show whether the acid had been taken as a poison. If the acid is found only in minute quantity, no inference of poisoning can be drawn unless there are distinct marks of its chemical action upon the throat and stomach. It darkens the blood like sulphuric acid, although it has not the same degree of carbonizing action on organic matter. The *stains* produced by this acid on black cloth are generally of a slight reddish colour. As the acid is volatile, it may disappear from the stuff. If recent, the acid may be separated by boiling the stuff in water and applying the silver test, or by boiling a portion of the stained cloth with leaf-gold and nitric acid. An unstained portion of cloth should be similarly tested for the sake of comparison.

CHAPTER 16.

POISONING BY VEGETABLE ACIDS. OXALIC ACID—SYMPTOMS AND EFFECTS—APPEARANCES AFTER DEATH—CHEMICAL ANALYSIS—ACID OXALATE OF POTASH OR SALT OF SORREL. TARTARIC ACID. ACETIC ACID. VINEGAR. PYROGALLIC ACID.

Oxalic Acid.

Symptoms.—If this poison is taken in a large dose, *i.e.* from half an ounce to an ounce of the crystals dissolved in water, a hot burning acid taste is experienced during the act of swallowing it. This is accompanied by a similar sensation extending through the gullet to the stomach. There is sometimes a sense of constriction or suffocation: the countenance is livid and the surface of the skin soon becomes cold and clammy. Vomiting occurs either immediately or within a few minutes. Should the poison be diluted, there is merely a sensation of strong acidity, and vomiting may not occur until after a quarter of an hour or twenty minutes. In some cases there has been little or no vomiting: while in others, this symptom has been incessant until death. In a case which occurred to Dr. Page, in which an ounce of the acid was swallowed, the vomiting with pain in the stomach continued until the fifth day, when the man died suddenly. ('Lancet,' Nov. 24, 1860, p. 509.) In a case in which the poison was much diluted, vomiting did not occur for seven hours. ('Christison,' 221.) The vomited matters are highly acid, and have a greenish-brown or almost black colour; they consist chiefly of mucus and altered blood. In one instance reported they were colourless. ('Medical Gazette,' vol. 37, p. 792.) In another case, reported by Mr. Deane in the 'Provincial Journal,' fluid blood of a bright arterial colour was vomited after some hours. (June 25th, 1851, p. 344.) There is great pain and tenderness in the abdomen, with a burning sensation in the stomach. There are cold clammy perspirations and convulsions. In a case which occurred at Guy's Hospital, in May 1842, in which about two ounces of the poison had been swallowed, there was no pain. Violent vomiting and collapse were the chief symptoms. There is in general an entire prostration of strength, so that if the person is in the erect position, he falls; there is likewise unconsciousness of surrounding objects, and a kind of stupor, from which, however, the patient may be without difficulty roused. Owing to the severity of the pain, the legs are sometimes drawn up towards the abdomen. The pulse is small, irregular, and scarcely perceptible; there is a sensation of tingling or numbness in the extremities, and the respiration, shortly before death, is spasmodic. The inspirations are deep, and a long interval elapses between them. Such are the symptoms commonly observed in a rapidly fatal or acute case.

Should the patient survive the first effects of the poison, the following symptoms may appear: there is soreness of the mouth, constriction and burning pain in the throat with pain in swallowing, tenderness in the abdomen, and irritability of the stomach, so that there is frequent vomiting, accompanied by purging. The tongue is swollen, and there is great thirst. The patient may slowly recover from these symptoms. In a case related by Mr. Edwards to the Westminster Medical Society, the patient, a female, lost her voice for eight days. Another case has been reported by Mr. T. W. Bradley, from which it may be inferred that a loss of voice may result from a direct effect of oxalic acid on the nervous system. A man swallowed a quarter of an ounce of the acid, and suffered from the usual symptoms in a severe form. In about nine hours his voice, although naturally deep, had become low and feeble. This weakness of voice remained for more than a month, and its

natural strength had not returned even after the lapse of nine weeks. During the first month there was numbness with tingling of the legs. ('Med. Times,' Sept. 14, 1850, p. 292.) The occurrence of this sensation of numbness, and its persistence for so long a period after recovery from the symptoms of irritation, clearly point to a remote effect of the poison on the nervous system. Spasmodic twitchings of the muscles of the face and extremities have also been observed in some instances. (See 'Lancet,' March 22, 1851, p. 329.)

Appearances after death.—The mucous membrane of the tongue, mouth, throat, and gullet, is commonly white, as if bleached; but it is sometimes coated with a portion of the brown mucous matter discharged from the stomach. This latter organ contains a dark brown mucous liquid, often acid, and having almost a gelatinous consistency. On removing the contents, the mucous membrane will be seen pale and softened, without always presenting marks of inflammation or abrasion, if death has taken place rapidly. This membrane is white, soft, and brittle, easily raised by the scalpel, and presents the appearance which we might suppose it would assume after having been for some time boiled in water. The small vessels are seen ramifying over the surface, filled with dark-coloured blood, apparently solidified within them. The lining membrane of the gullet presents the same characteristics. It is pale, and appears as if it had been boiled in water, or digested in alcohol; it has been found strongly raised in longitudinal folds, interrupted by patches where the membrane has become abraded. In a case which was fatal in eight hours, the tongue was covered with white specks; the gullet was not inflamed, but the stomach was extensively destroyed, and had a gangrenous appearance. Portions of the mucous membrane were detached, exposing the muscular coat. With respect to the intestines, the upper portion may be found inflamed; but, unless the case is protracted, the appearances in the bowels are not strongly marked. In a well-marked instance of poisoning by this acid, however, which is recorded by Dr. Hildebrand, the mucous or lining membrane of the stomach and duodenum was much reddened, although the patient, a girl of eighteen, died in three quarters of an hour after taking one ounce of the acid, by mistake for Epsom salts. (Casper's 'Vierteljahrsschrift,' 1853, 3 B. 2 H. page 256.) In a case of poisoning in which two ounces of the acid had been taken, and death was rapid, the coats of the stomach presented almost the blackened appearance produced by sulphuric acid, owing to the colour of the altered blood spread over them. In protracted cases, the gullet, stomach, and intestines have been found more or less congested or inflamed. In a case in which an ounce was swallowed, and death occurred on the fifth day, the stomach was slightly congested, and contained a bloody fluid, but the mucous membrane was entire. ('Lancet,' Nov. 24, 1860, p. 509.)

I am indebted to Mr. Welch for the following case:—A woman, aged 28, swallowed *three drachms* of the crystallized acid. She was found quite dead in *one hour* afterwards. On examining the body, both lungs were observed to be extensively congested, and the heart and large vessels were full of dark-coloured blood. The stomach contained about three-quarters of a pint of a dark-brown fluid, and its lining membrane was generally reddened. The other organs, except the brain, were healthy, and this presented appearances indicative of long-standing disease. This case is remarkable from the smallness of the dose, the rapidity of death, and the early production of a well-marked redness of the mucous membrane of the stomach. The diseased state of the body may have tended to accelerate death from the poison. In one instance the larynx was found filled with frothy mucus, and the left side of the heart and the lungs were gorged with dark-coloured fluid blood. In another, the appearances of sanguineous apoplexy were found in the brain. A person fell dead after retching violently. Apoplexy was supposed to be

the cause of death. On an inspection of the body, it was found that a large clot of blood was effused on the brain, and this appeared to account for death satisfactorily. But when the stomach was examined, oxalic acid was detected in it. This poison had been taken, and had produced its usual effects. The deceased had taken it with suicidal intention, and the violent vomiting which it caused had led to death by apoplexy from effusion of blood. ('Lancet,' 1863, 1, p. 47.) Without a proper chemical investigation, it is obvious that the real cause of death would have been in this instance overlooked. In a few cases there have been scarcely any morbid appearances produced by this poison.

It is worthy of remark that the glairy contents of the stomach or its coats do not always indicate strong acidity until after they have been boiled in water. Oxalic acid does not appear to have a strongly corrosive action on the stomach, like that possessed by the mineral acids. It is therefore rare to hear of the coats of the organ being perforated by it. In many experiments on animals, and in some few observations on the human subject, I have found nothing to bear out the view that perforation is a common effect of the action of this poison. The acid undoubtedly renders the mucous coat soft and brittle, and perforation of the coats may occur either during life or after death as a result of its chemical action. Dr. Wood has recorded the case of a female, æt. 27, found dead, whose death had been obviously caused by oxalic acid, but the quantity taken, and the duration of the case, were unknown. The stomach presented, at its upper and fore part near the cardiac opening, an irregular aperture of a size to admit the point of the finger. From this, a dark gelatinous-looking matter, resembling coffee-grounds, was escaping in abundance. The perforation was enlarged during the removal, and presented the appearance of two large apertures separated by a narrow band. The stomach contained a bloody fluid, in which oxalic acid was detected, and the mucous membrane had an eroded appearance. The small intestines (jejunum and ileum) were similarly affected.

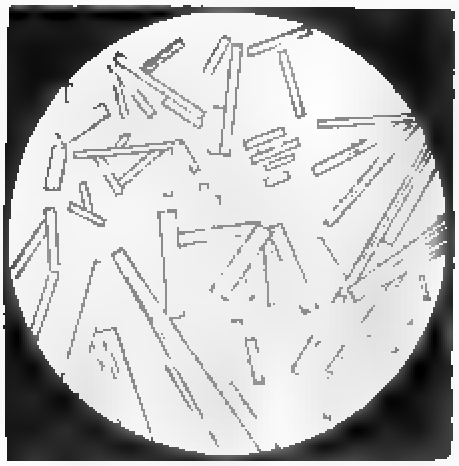
Quantity required to destroy life.—The smallest quantity of this poison which has been known to destroy life is *one drachm* (sixty grains). The boy, æt. 16, was a patient of Dr. Barker of Bedford. He took the acid in a solid form, and was found in about an hour insensible, pulseless, and his jaws spasmodically closed. He had vomited some bloody matter: his tongue and lips were unusually pale, but there was no excoriation. He died in eight hours. ('Lancet,' Dec. 1, 1855.) In Mr. Welch's case (suprà) *three drachms* destroyed life in an hour. Two cases occurred at Guy's Hospital, in each of which half an ounce of oxalic acid had been swallowed. Active treatment was adopted and both patients recovered. When the dose is upwards of half an ounce, death is commonly the result; but one of my pupils informed me of a case in which a man recovered after having taken an ounce of crystallized oxalic acid. Dr. Brush, of Dublin, has communicated to the 'Lancet' a case in which recovery took place after a similar dose of the poison had been taken. (See also a case by Mr. Alison in the same journal, Nov. 2, 1850, p. 502.) The acid was in this instance taken by mistake for Epsom Salts. Dr. Ellis met with a case of recovery in a woman æt. 50. She swallowed an ounce of the acid in beer. In half an hour she was found complaining of a burning pain in the stomach, and rolling about. Chalk and water were freely given, and she recovered. ('Lancet,' Sept. 3, 1865, p. 265.)

Period at which death takes place.—Similar quantities of this poison do not destroy life within the same period of time. In two cases, in which about two ounces of the acid were respectively taken, one man died in twenty minutes—the other in three-quarters of an hour. Sir R. Christison mentions an instance in which an ounce killed a girl in thirty minutes; and another

in which the same quantity destroyed life in *ten minutes*; but in a third case death did not occur until the fifth day. The late Dr. Ogilvy, of Coventry, has reported a case of poisoning by oxalic acid, in which it is probable that death took place within *three minutes* after the poison had been swallowed. The sister of the deceased had been absent from the room about that period, and on her return found her dying. The *quantity* of poison taken could not be determined. When the dose of oxalic acid is half an ounce and upwards, death commonly takes place in an hour. There are, it must be admitted, numerous exceptions to this rapidity of action. Sir R. Christison reports two cases which did not prove fatal for thirteen hours; and in an instance that occurred to Mr. Fraser, in which half an ounce was taken, the individual died from the secondary effects in a state of perfect exhaustion, thirteen days after taking the poison. Sixty deaths from this poison in England and Wales were recorded in four years—1863–7.

Chemical Analysis. In the simple state.—This acid may be met with, either as a solid or in solution in water. *Solid oxalic acid.* It crystallizes in long slender prisms, which, when perfect, are four-sided. In this respect it differs from other common acids, mineral and vegetable. The crystals are unchangeable in air; they are soluble in water and alcohol, forming strongly acid solutions. When heated on platinum-foil they melt, and are entirely dissipated without combustion and without being carbonized. Heated gently in a close tube, they melt, and the vapour is condensed as a white crystalline sublimate in a cold part of the tube. The crystals are prismatic, like those obtained from the solution. There should be no residue whatever if the acid is pure: but the commercial acid generally leaves a slight residue of fixed impurity. By this effect of heat, oxalic acid is easily distinguished from those crystalline salts for which it has been sometimes fatally mistaken, namely, the sulphates of magnesia and zinc. These leave white residues in the form of anhydrous salts. A teaspoonful of oxalic acid in small crystals weighs seventy-six grains, and half an ounce of the crystals is equivalent to three teaspoonfuls.

Fig. 6.



Crystals of Oxalic Acid, magnified 30 diameters.

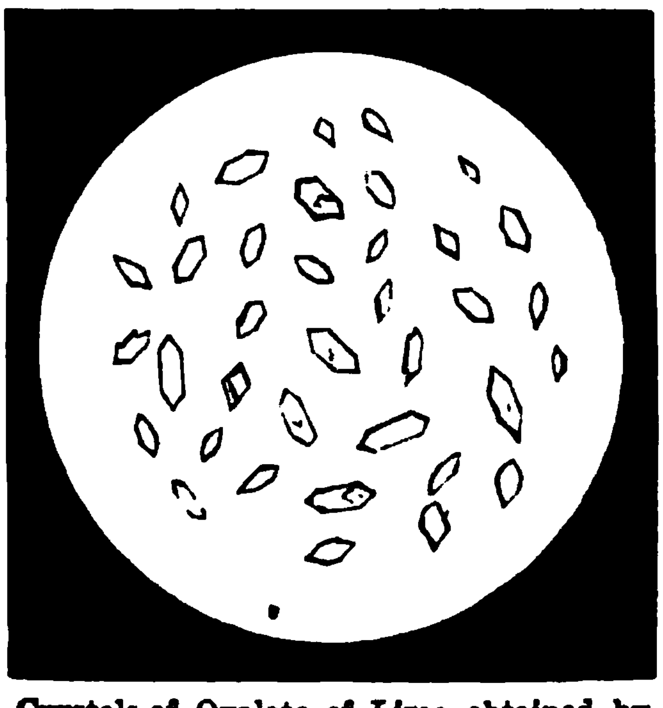
Tests for the solution.—1. *Nitrate of silver.*—When added to a solution of oxalic acid, it produces an abundant white precipitate of oxalate of silver. A solution containing so small a quantity of oxalic acid as not to redden litmus-paper, is affected by this test; but when the quantity of poison is small, it would be always advisable to concentrate the liquid by evaporation before applying the test. The oxalate of silver is identified by the following properties: 1. It is completely dissolved by cold nitric acid. If collected on a filter, thoroughly dried, and heated on thin platinum-foil, it is entirely dissipated in a white vapour with a slight detonation. When the oxalate is in small quantity, this detonation may be observed in detached particles on burning the filter previously well dried. 2. *Sulphate of lime.* A solution of oxalic acid is precipitated white by lime water and all the salts of lime. Lime water is itself objectionable as a test, because it is precipitated white by several other acids. The salt of lime which, as a test, is open to the least objection, is the *sulphate*. As this is not a very soluble salt, its solution must be added in rather large quantity to the suspected acid poisonous liquid. A white precipitate of oxalate of lime is slowly formed. This precipitate should possess the following properties:—1. It ought to be immediately dissolved by nitric or hydrochloric

acid. 2. It ought not to be dissolved by the oxalic, tartaric, acetic, or any vegetable acid.

In liquids containing organic matter.—The process is the same, whether it is applied to liquids in which the poison is administered, or to the *matters vomited*, or lastly, to the *contents of the stomach*. This poison readily combines with albumen and gelatine, and it is not liable to be decomposed or precipitated by these or any other organic substances: it is, therefore, commonly found in solution in the liquid portion, which will then be more or less acid. As a trial-test we may employ either a solution of sulphate of copper or lime water. 1. A portion of the liquid should be boiled to remove any albumen, and after filtration, a solution of sulphate of copper should be added to it. If oxalic acid is present in moderate quantity, a greenish-white precipitate will be formed. 2. Lime water may be added to a portion of the clear liquid. A white precipitate will be produced, insoluble in acetic acid, if oxalic acid is present.

From milk, gruel, coffee, blood, mucus and other viscid liquids, oxalic acid is readily separated by the process of dialysis, as described under sulphuric acid (see page 215). The liquid should be first boiled—the coats of the stomach (cut up) being included, if necessary. The distilled water placed on the outside of the tube will receive the acid. This may be concentrated by evaporation. Prismatic crystals may thus be procured, and the silver and lime tests may be applied. Oxalic acid may be completely separated from the boiled and filtered organic liquid by the following process. To the filtered liquid, acidulated with acetic acid, *acetate of lead* should be added until there is no further precipitation; and the white precipitate formed, collected and washed. If any oxalic acid was present in the liquid, it would exist in this precipitate under the form of oxalate of lead. To separate oxalic acid from the oxalate of lead we diffuse the precipitate in water, and pass into the liquid, for about half an hour, a current of sulphuretted hydrogen gas, taking care that the gas comes in contact with every portion of the precipitate. Black sulphide of lead will be thrown down: and with it commonly the greater part of the organic matter, which may have been mixed with the oxalate of lead. Filter, to separate the sulphide of lead; the filtered liquid may be clear and highly acid. Concentrate by evaporation; the sulphuretted hydrogen dissolved in the liquid is thereby expelled, and oxalic acid may be ultimately obtained crystallized by slow evaporation in a dial or watch-glass, or on a glass-slide, for microscopical observation. If there was no oxalic acid in the precipitate, no crystals will be procured by evaporation. If crystals are obtained, they must be dissolved in water, and tested for oxalic acid in the manner above directed.

Fig. 7.



Crystals of Oxalate of Lime obtained by dialysis of Coffee containing Oxalic Acid, magnified 350 diameters.

The presence of oxalic acid in an organic liquid may be detected by another method. Place a portion of the liquid containing the poison in a beaker, and insert in this a tube secured with skin, containing a solution of sulphate of lime. By dialysis or osmosis the oxalic acid will penetrate the membrane, and will form inside the mouth of the latter a deposit of crystals of oxalate of lime, known by their octahedral form.

Sometimes the chemical evidence may depend on *stains* on articles of *clothing*. Oxalic acid discharges the colour of some dyes, and slowly reddens others;

but unless the stuff has been washed, the acid remains in the fabric and may there be detected. It does not corrode or destroy the stuff like mineral acids. In *Reg.* v. *Morris* (C. C. C. December 1866) it was proved that the prisoner had attempted to administer a liquid poison forcibly to her daughter, a girl aged six years. It was sour in taste, made her lips smart, and caused vomiting. There was dryness of the lips, and inflammation of the lining membrane of the mouth. No portion of the substance administered could be procured, but a crystalline deposit of oxalic acid was obtained from some stains on the dress of the child. The woman was convicted.

Dr. White (U.S.) has published an elaborate report of a case of poisoning with oxalic acid, in which the symptoms and appearances are contrasted with those caused by disease, and compared with those usually assigned to oxalic acid. The poison was not detected in the contents of the stomach, but the sheets on which the patient had vomited yielded from one to two grains of oxalic acid. The patient lived forty hours after vomiting had set in. (Boston Med. and Surg. Jour. Jan. 27, 1870.)

As oxalic acid is very soluble in alcohol, this liquid may be occasionally employed for separating it from the contents of the stomach and from many organic compounds. Large and perfect crystals may be obtained from the alcoholic solution, and these may be purified and tested by the methods already described.

In cases of poisoning, the residuary quantity found in the stomach is generally small. In one instance, in which about an ounce and a half had been taken, and the person died in two hours, I found only thirteen grains. In a case which occurred at Bristol, in 1868, a woman took three-quarters of an ounce of oxalic acid (360 grains), and died in ten minutes. It is stated that not more than two grains were obtained from the coats of the stomach. The vomiting had been violent, and the greater part of the poison had been thus ejected. It seems that the woman had vomited into a pail containing calcareous water, and it was observed that this water acquired a milky white appearance, owing to the action of the acid on the salts of lime. ('Chem. News,' April 24, 1868, p. 205, and 'Pharm. Jour.' May, 1868, p. 543.) In *Reg.* v. *Cochrane* (Liverpool Summer Assizes, 1857), in which it was charged that two children, aged six and four years respectively, had been wilfully poisoned by their mother, it was stated by the medical witness, Dr. Edwards, that he found forty-two grains of oxalic acid in the stomach of the elder, and twenty grains in that of the younger child. It was not clearly established when or how this large quantity of poison could have been wilfully administered to the children, and the prisoner was acquitted.

Acid Oxalate of Potash or Salt of Sorrel.

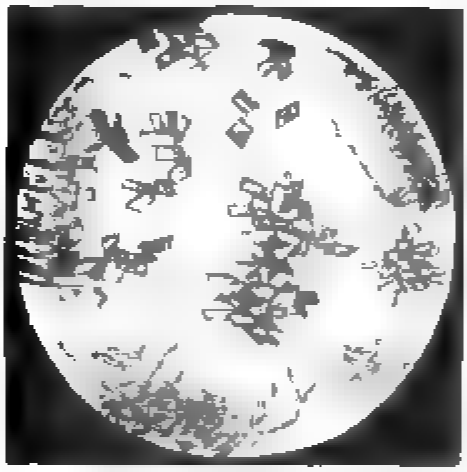
Symptoms and Effects.—The poisonous effects of this salt entirely depend on the oxalic acid which it contains. It is much used for the purpose of bleaching straw and removing ink-stains, being sold under the name of essential salt of lemons. Its poisonous properties are not generally known, or no doubt it would be frequently substituted for oxalic acid. Out of three cases of poisoning by this substance two proved fatal, while in the other the patient recovered. In the case of recovery, a young lady, aged 20, swallowed an ounce of the salt dissolved in warm water. She was not seen by any one for an hour and a half: she was then found on the floor, faint and exhausted, having previously vomited considerably. There was great depression, the skin cold and clammy, the pulse feeble, and there was a scalding sensation in the throat and stomach, with continued shivering. Proper medical treatment was adopted, and she recovered in two days, still suffering from debility and great irritation of the stomach. During the state of

depression, it was remarked that the conjunctivæ (membranes of the eyes) were much injected, and the pupils dilated. There was also great dimness of vision. ('Med. Gaz.' vol. 27, p. 480.) In another case, two hundred and twenty-five grains were taken (about half an ounce). Bicarbonate of soda was given as an antidote, and the patient completely recovered. ('Med. Times and Gazette,' Feb. 12, 1859.) The recovery must have taken place in spite of the antidote, for the oxalate of soda is just as poisonous as the oxalate of potash. For a third case of recovery, see the same journal, Oct. 15, 1859, p. 378.

This salt destroys life almost as rapidly as oxalic acid itself; and in the symptoms which it produces, it closely resembles that poison. In one case, half an ounce killed an adult in so short a time as *eight minutes*; but probably the fatal effects were in this instance accelerated by the debilitated state of the person who took it. In another case, reported by M. Chevallier, death took place in ten minutes. ('Ann. d'Hyg.' 1850, 1, 162). In one instance in which it was supplied by mistake for Epsom salts, it caused death in an hour and a half ('Pharm. Jour.' March 1872, p. 760). In a case reported in the 'Ed. Monthly Journal' (July 1862, p. 92) death appears to have been caused by this salt as the result of chronic poisoning. A girl was charged with the murder of her father. He began to be ill about December 5, and he died on January 26 following. He suffered from vomiting, heat and irritation in the mouth and throat, prostration of strength and constant pains in the chest and abdomen. After death, the appearances were—inflammation of the mucous membrane of the stomach and part of the bowels. They contained a dark-coloured fluid. The mucous membrane of the gullet was destroyed. The coats of the stomach, which were thickened and injected, had a gangrenous appearance. There was no proof that the prisoner had had possession of the poison until January 11, five weeks after the symptoms had begun in the deceased. The symptoms before and subsequently to this date were similar. This absence of proof of possession led to the acquittal of the prisoner; still it would be difficult to account for the symptoms and appearances on any theory of disease.

Chemical Analysis.—This salt is not very soluble in cold water, but its solution may be readily mistaken for that of oxalic acid. It is not dissolved by alcohol. 1st, the aqueous solution has an acid reaction; and 2nd, it is precipitated by nitrate of silver and sulphate of lime, like oxalic acid: but with the latter test the precipitation is much more copious. It is distinguished from oxalic acid. 1. By its crystals, which when slowly produced on a glass slide assume the shape of small rhombic prisms, sometimes grouped in a plumose form; and 2. By heating a portion on platinum-foil. While oxalic acid is entirely volatile, the binoxalate leaves an ash, which, when sufficiently heated, is white and alkaline; it may be proved to contain carbonate of potash by its dissolving with effervescence in diluted nitric acid, and forming nitrate of potash.

Fig. 8.



Crystals of Acid Oxalate of Potash, magnified 30 diameters.

In some instances this poisonous salt has been supplied by mistake for cream of tartar, and has caused death. Cream of tartar, or acid tartrate of potash, leaves a black alkaline residue when heated in close vessels. Its solution is less acid than that of the salt of sorrel. It is not precipitated by the nitrate of silver or sulphate of lime. The different action of the two salts on writing-ink affords a simple means of identification. The binoxalate

of potash immediately discharges the colour of ink when warmed, while the acid tartrate does not possess this property.

Tartaric Acid.

Symptoms and Appearances.—Tartaric acid is not commonly regarded as a poison; but one case has occurred, in which there was no doubt that it acted as an irritant and destroyed life. The case referred to was the subject of a trial for manslaughter at the Central Criminal Court (*Reg.* v. *Watkins*, in January 1845). The accused gave to the deceased, a man aged 24, *one ounce* of tartaric acid instead of aperient salts. The deceased swallowed the whole, dissolved in half a pint of warm water; he immediately exclaimed that he was poisoned; he complained of having a burning sensation in his throat and stomach, as though he had drunk oil of vitriol, and stated that he could compare it to nothing but being all on fire. Soda and magnesia were administered with diluent drinks. Vomiting set in, and continued until death, which took place nine days afterwards. On inspection, nearly the whole of the alimentary canal was found highly inflamed. The accused admitted that he had made a mistake, and tartaric acid was found in the dregs of the cup. The jury acquitted the prisoner. Another case of poisoning by this acid, with a report of the results of analysis, has been published by M. Devergie. ('Ann. d'Hyg.' 1851, 2, 432.) This case gave rise to a controversy between the late M. Orfila and M. Devergie, the points in dispute relating chiefly to the processes for the detection of the acid in the stomach and tissues. (See 'Ann. d'Hyg.' 1852, 1, 199, 382; and 2, 230.)

Acetic Acid.

This acid has been generally excluded from the class of poisons. Common *Vinegar*, which contains only five per cent. of acetic acid, has been often taken in large doses without injurious consequences. From the experiments performed by Orfila on dogs, and from one case which he reports as having occurred in the human subject, acetic acid, when concentrated, appears to exert an irritant action on the body. ('Annales d'Hygiène,' 1831, 2, 159: also 'Toxicologie,' vol. 2, p. 198.) This is not more than we might have expected, seeing that the concentrated acid is highly corrosive. In the case referred to, the deceased, a female aged 19, was found dying on the highway. She suffered from convulsions, complained of pain in the stomach, and died in a short time. On inspection, the stomach was found neither softened nor corroded, but its mucous membrane near the pylorus was almost black. The mucous glands were prominent, and the vessels were filled with dark coagulated blood.

Vinegar, which may be regarded as an organic mixture containing a small proportion of acetic acid, may be examined by distilling a portion, and testing the distilled liquid for the acid. Vinegar, as it exists in commerce, always contains a small quantity of sulphuric acid, and occasionally traces of arsenic, lead, and copper. In general it is easily recognized by its odour. Pelletan observed in the case of a child, that the abuse of vinegar led to a thinning of the mucous membrane of the stomach; and Landerer remarked that the milk of a wet-nurse who had been in the habit of taking large quantities of the Vinegar of Roses, became thin, very acid, and deficient in casein and oil. The infant which she was suckling gradually wasted and died, and the woman herself suffered severely. (Heller's 'Archiv.' 1847, 2 H. S. 185.)

Pyrogallic Acid.

Poisonous properties have been attributed to this well-known substance, which is so much employed in photography. I have not met with any case

of poisoning by it in the human subject; but according to M. Personne, it operates powerfully on animals. Two healthy dogs were selected, and into the stomach of one a dose of two grains of pure pyrogallic acid, dissolved in water, was injected; and twice this quantity was administered to the other dog. The animals died after fifty and sixty hours respectively. The symptoms are said to have resembled those of phosphorus-poisoning, and after death the muscular tissue of the heart was found in each case to have undergone fatty degeneration. The acid is supposed to act like phosphorus in arresting oxidation changes by absorbing and removing oxygen. The alkalinity of the blood would favour this chemical action. ('Medical Press,' December 1869; 'Amer. Jour. of Med. Sci.' July 1870, p. 275.)

CHAPTER 17.

POISONING BY THE ALKALIES: POTASH, SODA, AND THEIR CARBONATES—SYMPTOMS —FATAL EFFECTS OF THE CARBONATE OF POTASH—APPEARANCES AFTER DEATH— AMMONIA AND ITS CARBONATE (SAL VOLATILE)—CHEMICAL ANALYSIS.

POTASH AND SODA.

Symptoms.—The symptoms produced by potash and soda, when taken in large doses, are similar, and one description will serve for both. Cases of alkaline poisoning are, however, rare, and have been, generally, the result of accident. The most common form in which these poisons are met with, is in the state of pearlash (carbonate of potash) and soap-lees (carbonate of soda). The patient experiences, during the act of swallowing, an acrid caustic taste, owing to the alkaline liquid, if sufficiently concentrated, excoriating the mucous membrane. There is a sensation of burning heat in the throat, extending down the gullet to the stomach. Vomiting is not always observed; but when it does occur, the vomited matters are sometimes mixed with blood of a dark brown colour, and with detached portions of mucous membrane: this effect depending on the degree of causticity in the liquid swallowed. The surface is cold and clammy: there is purging, with severe pain in the abdomen, resembling colic. The pulse is quick and feeble. In the course of a short time, the lips, tongue, and throat become swollen, soft, and red.

Appearances after death.—In recent eases there are marks of the local action of the poison on the mucous membrane of the mouth, throat, and gullet. This membrane has been found softened, detached, and inflamed in patches of a deep chocolate colour, sometimes almost black. A similar appearance has been met with in the mucous membrane of the larynx and windpipe. The stomach has had its mucous surface eroded in patches, and there has been partial inflammation. In one instance, as a result of the action of soda, I found it puckered and blackened.

Period of death.—The most rapidly fatal case which I have found reported is that of a boy, who died in *three hours* after swallowing three ounces of a strong solution of carbonate of potash. In a case which occurred in 1835, a child, aged three years, took a small quantity of concentrated solution of pearlash which had deliquesced, and died in twenty-four hours. Death was caused in this instance by the inflammation induced in the larynx, causing suffocation. In this respect, the caustic alkalies may destroy life rapidly, like the mineral acids; but death may be also a slow result of these poisons. Thus, in an instance which was communicated to me, a lady swallowed, by mistake,

one ounce and a half of the common solution of potash of the shops, which contains about five per cent. of caustic alkali. She recovered from the first symptoms of irritation, but died seven weeks afterwards from pure exhaustion, becoming greatly emaciated before her death. The alkali had probably destroyed the lining membrane of the stomach, and had thus impaired digestion.

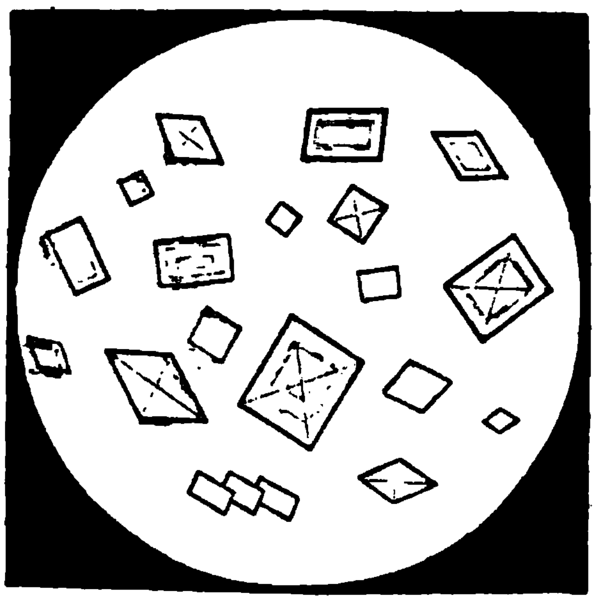
Carbonates.—Dr. Barclay has reported a case of poisoning by potash, which furnishes a good illustration of the after-effects and appearances caused by this poison. A woman, aged 44, was admitted into St. George's Hospital, May 2, 1853, about six hours and a half after she had swallowed a quantity of American potash, probably a saturated solution of carbonate of potash (American pearlash). She had vomited immediately after taking it. The mouth and throat were much corroded. There was burning pain in the throat and gullet, extending downwards to the stomach; but there was no tenderness on pressure. Two days after her admission, there was a little vomiting. The mucous membrane, so far as it could be seen, was destroyed; there was difficulty of swallowing, and occasionally pain after food had entered the stomach. In about a month, there was frequent vomiting, with pain on pressure, and constipation; when food or medicine was taken, there was much pain in the stomach, and in a short time the food was ejected. As the case progressed, nothing could be retained on the stomach, and shortly before death the patient was supported only by nutritive injections. She died from starvation on July 8, about two months after taking the alkali. On inspection. the lower part of the gullet was found much contracted, the lining membrane entirely destroyed, and the muscular coat exposed. The external coats were much thickened. The gullet end of the stomach, where the ulceration ceased, was considerably contracted. At the intestinal end the mucous lining presented a large and dense cicatrix, obstructing all communication with the small intestines, except by an orifice no larger than a probe. The intervening portion of the stomach was healthy, as were also the large and small intestines. ('Med. Times and Gazette,' Nov. 26, 1853, p. 554.) In December 1867 a case of poisoning by pearlash gave rise to a trial for manslaughter at Manchester (*Reg.* v. *Boothman*). A solution of this substance had been prepared for washing purposes. The prisoner offered some to a man, who tasted it and immediately called for water. The deceased took some, and was soon afterwards seen in the yard vomiting and in great pain. This was on May 31: he was admitted into an hospital, where he remained until August 2, suffering all the time, and unable to swallow anything but thin fluids. On leaving the hospital he went home and died on September 20, nearly four months after swallowing the alkaline liquid. He died from starvation, as a result of stricture of the gullet. The quantity taken was unknown, but the liquid was sufficiently strong to soften and destroy the mucous membrane of the throat.

Orfila refers to two cases of poisoning by carbonate of potash, in each of which half an ounce of this substance was taken by mistake for aperient salts. The patients, two young men, recovered from the first effects, but ultimately died: the one three months, and the other four months, after the poison had been taken. The secondary fatal effects appear to have been due to constant purging, great irritability of the stomach leading to incessant vomiting, and loss of the functions of this organ from the destruction of the lining membrane, with stricture either of the gullet or of the apertures of the stomach,—either of which causes might prove fatal at almost any period. A fatal case of stricture, produced by soap-lees after the lapse of two years and three months, is reported by Dr. Basham ('Lancet,' March 2, 1850). The constant use of the alkalies or of their carbonates appears to be productive of latent mischief: yet the quantity which may be sometimes taken in

divided doses without destroying life is enormous. Dr. Tunstall, of Bath, relates the case of a man who, for eighteen years, had been in the habit of taking bicarbonate of soda to remove dyspepsia. It is stated that for sixteen years he took *two ounces* of the bicarbonate daily! The man died suddenly, and on examining the stomach it was found to be greatly distended and extensively diseased—conditions which were referred by Dr. Tunstall to the action of the carbonate of soda. ('Med. Times,' Nov. 30, 1850, p. 564.) The *quantity* of any of these alkaline poisons required to destroy life is unknown. The fatal effects depend rather on the degree of concentration of the liquid, than on the absolute quantity of alkali present.

Chemical Analysis.—Solutions of POTASH AND SODA have a strongly alkaline reaction; they are distinguished from those of their respective carbonates by giving brown precipitates with a solution of nitrate of silver. The CARBONATES, on the other hand, yield a whitish-yellow precipitate. POTASH is known from SODA by the following characters:—1. Its solution, when not too much diluted with water, is precipitated of a canary-yellow colour by perchloride of platinum. 2. It is precipitated in granular white crystals, on adding the alkaline liquid gradually to a strong solution of tartaric acid, containing a small quantity of alcohol, and occasionally stirring the mixture. SODA is not precipitated by either of these tests, which will serve equally to distinguish the *salts of potash* from those of soda, if we except the acid oxalate and acid tartrate of potash: these, from being but little soluble in water, are not precipitated. 3. If we neutralize the two alkalies by diluted nitric acid, and crystallize the liquid on a slip of glass,—should the alkali be potash, the crystals will have the form of long slender fluted prisms (p. 220); if soda, of rhombic plates. 4. Potash and its salts are known by their giving a reddish-violet colour, while soda and its salts give a bright yellow colour to a colourless flame.

Fig. 9.



Rhombic crystals of Nitrate of Soda, magnified 30 diameters.

In liquids containing organic matter.—Such liquids are frothy; they possess an alkaline reaction, a peculiar alkaline odour, and are soapy to the feel. The organic liquid may be evaporated to dryness, then heated in a porcelain capsule to char the animal and vegetable matter, and the alkali will be recovered from it in a state of carbonate by digesting the residuary ash in distilled water.

AMMONIA. SPIRIT OF HARTSHORN.

The *vapour* of strong ammonia is poisonous. It may destroy life by producing violent inflammation of the larynx, or of the lungs and air-passages. It is often injudiciously employed to rouse persons from a fit. A case is on record of an epileptic having died under all the symptoms of croup, two days after the application of strong ammonia in vapour to the nostrils: it was employed to rouse him from a fit. A singular case of recovery from the poisonous effects of this vapour, by Dr. Sanchard, is reported in the 'Annales d'Hygiène' (Janvier 1841). A case of poisoning by the vapour breathed in the manufacture of ice from liquefied ammonia is reported (Husemann's 'Jahresbericht' 1872, Toxicologie, p. 470). The effects were chiefly manifested in the lungs, and many days elapsed before recovery took place.

Symptoms and Appearances.—The strong *solution* of ammonia produces

symptoms similar to those described in speaking of potash. The only difference observed is, that the sense of heat and burning pain in the throat, gullet, and stomach, is much greater. Cases of this form of poisoning are rare. Dr. Sanchard relates an instance that occurred in France, in which a boy, only six years old, poisoned his younger sister by pouring several teaspoonfuls of a strong solution of ammonia down her throat. In one case a strong dose of the solution killed a man in *four minutes*, by causing suffocation (Christison, 167): and another case is referred to in the 'Journal de Pharmacie' (Oct. 1846, p. 285), in which from one to two drachms of solution of ammonia, unknowingly administered, caused death. There was violent vomiting, with bloody purging; and, on inspection, blood was found effused in the intestines. There was also a remarkably fluid state of the blood in the body. In another instance, a man walked into a druggist's shop, and asked for a small quantity of ammonia to take spots out of his clothes. The druggist poured about a teaspoonful and a half into a glass. The man suddenly swallowed it, and fell instantly to the ground. He soon afterwards died, complaining of the most excruciating pain. ('Journal de Chimie Médicale,' 1845, p. 531.) A similar case occurred at Halifax in April 1857: a man swallowed a large dose of ammonia, and died in a quarter of an hour. In other cases, in spite of a large dose, death has taken place slowly. Dr. Potain met with an instance in which a man swallowed upwards of three ounces of the commercial solution of ammonia, and he did not die from the effects until the eleventh day. ('Journal de Chimie Médicale,' 1862, pp. 341 and 474.)

Serious injury to the organs of respiration is sometimes the result of the action of this poison, as in the following case, which was referred to me for examination by my colleague, Mr. Hilton, in May 1857. A gentleman liable to attacks of fainting died in three days after swallowing a quantity of a liquid administered to him by his son. This liquid, which was at the time believed to be sal volatile, was, in fact, a strong solution of ammonia. The deceased complained immediately of a sensation of choking and strangling in the act of vomiting. Symptoms of difficulty of breathing set in, with other signs of irritation in the throat and stomach. The mucous membrane of the mouth and throat was corroded and dissolved: and it was evident that the liquid had caused great local irritation. The difficulty of breathing was such as to threaten suffocation, and at one time it was thought that an operation must be resorted to. The state of the patient, however, precluded its performance, and he died on the third day. On *inspection*, the viscera presented strong marks of corrosion. The covering of the tongue was softened, and had peeled off; the lining membrane of the air-passages was softened and covered with layers of false membrane, the result of inflammation, and the larger bronchial tubes were completely obstructed by casts or cylinders of this membrane. The lining membrane of the gullet was softened, and at the lower part, near its junction with the stomach, the tube was completely dissolved and destroyed. There was an aperture in the stomach in its anterior wall, about one inch and a half in diameter: the edges were soft, ragged, and blackened, presenting an appearance of solution. The contents of the stomach had escaped. On the inside, the vessels were injected with dark-coloured blood, and there were numerous small effusions of blood in various parts of the mucous membrane. The coats were thinned and softened at the seat of the aperture. The blackened and congested appearance somewhat resembled that which is seen in poisoning by sulphuric or oxalic acid. The mucous matter on the coats of the stomach was feebly *acid*. No poison of any kind was found in the layer of mucus or in the coats. There was not in any part the slightest trace of ammonia, the poison which had caused the mischief. The deceased had lived three days: remedies had been used, and every trace of ammonia had disap-

peared. The immediate cause of death was an obstruction of the air-tubes, as a result of inflammation, caused by the local irritant action of the poison. It was quite obvious that a quantity of the liquid had entered the windpipe. The perforation of the stomach had probably taken place shortly before death, or there would have been marks of peritonitis. The injury to the stomach and gullet would have been sufficient to cause death, even supposing that the liquid had not penetrated to the lungs. Dr. Patterson met with a case in which a man, æt. 40, swallowed an ounce of spirit of hartshorn. He ejected the liquid almost immediately, and complained of an intense burning pain and feeling of suffocation. None of it, he thought, had reached the stomach. Dr. Patterson saw him in two hours; his countenance was then suffused and anxious, the lips were livid, breathing difficult, extremities cold, pulse 100, and the inside of the mouth and throat was raw and fiery-looking. He complained of pain in the situation of the larynx and under the left ear. The larynx was opened to relieve the breathing, but the relief was only temporary. He vomited blood, and before death suffered from great difficulty of swallowing. He died in nineteen days after taking the poison, obviously from the local injury done to the parts about the larynx. ('Ed. Med. Jour.' 1857, vol. 2, p. 236.) Dr. Kern relates the case of a man, æt. 70, who took two mouthfuls of spirits of ammonia. He was immediately afterwards seized with a sense of suffocation, cough and vomiting, and in spite of treatment he died in four hours. The lining membrane of the mouth and throat was destroyed. There was a bloody fluid, smelling of ammonia, in the stomach. At the lower portion, the lining membrane was corroded and the muscular coat changed into a black pulpy substance. The duodenum was also inflamed. ('Amer. Jour. Med. Sci.' January 1870, p. 275.) A man swallowed by mistake for a dose of cod-liver oil, a tablespoonful of solution of ammonia. Œdema of the glottis followed, and in five hours he died from suffocation. ('Lancet,' 1870, 1, 467.) Eleven deaths from ammonia are reported to have occurred in England and Wales in four years—1863–7.

Mr. Tyerman communicated to me the particulars of a case which occurred in Nov. 1858, in which a lunatic, æt. 62, swallowed about two fluid ounces of compound camphor liniment. The patient immediately complained of great heat in the stomach; vomiting was induced by giving to him warm water. The uvula, throat, and gullet were so intensely inflamed that he lost all power of swallowing; and the efforts to swallow liquids produced violent retching. The symptoms gradually abated, and the man recovered in four days. In this case the quantity of ammonia swallowed was small, amounting to about two and a half drachms, diluted with about six times the quantity of rectified spirit. One of my pupils, Mr. Gill, communicated to me a case of the poisoning of an infant, only four and a half days old, by a small quantity of this liniment. The case occurred in September 1863. Mr. Gill saw the infant about half an hour after the liquid had been taken; it was then screaming in a suppressed manner, as if the act increased the pain: the hands were tightly clenched; the skin was pale and covered with a cold perspiration: the mucous membrane of the lips was blistered, and that of the mouth and tongue was white. A yellowish froth escaped from the mouth and nostrils; breathing was painful, and the pulse imperceptible. In about two hours the infant appeared better, but at intervals it suddenly started and screamed, as if from sudden pain. In six hours it continued much in the same state, and swallowing was painful. In seventeen hours the skin was moist and cool. it had had a natural motion, and had been in a drowsy state during the night. After twenty-four hours the infant was much weaker; the limbs were cold, and the breathing was feebly performed. It became drowsy, and died thirty-two hours after taking the poison. There was an inquest, but no inspection

of the body. A question of importance arose in reference to the case: namely, whether the mother or a child, two years of age, criminally administered the poison to the deceased infant. The mother stated that this child was playing with the bottle of embrocation on the bed, on which her infant was lying. She left the room for a short time, and on her return she gave the infant a teaspoonful of food which she had previously prepared for it. She was sure the infant swallowed part of the food; but as soon as the food was taken, it screamed violently and struggled for its breath, and then she perceived the food to smell strongly of the embrocation. As from the nature of this irritant compound the symptoms could not be suspended, it is clear that the mother either consciously or unconsciously gave the poison to her infant. On the latter supposition, it must have been placed in the food which was on a chair near to the bed by the child of two years, during her absence; but in this case it is remarkable that she did not perceive the odour until after she had poured the liquid into the mouth of the infant. The quantity swallowed was unknown. In the 'Medical Times and Gazette' for May 26, 1855, there are two cases reported, in which children were poisoned by swallowing a liniment of ammonia and oil. In one, an infant, death occurred speedily, probably from swelling and closure of the air-passages, thus leading to suffocation. In the other case, death took place on the following morning. Considering the hot taste of ammonia, it is remarkable that an infant could have had the power of swallowing nearly two ounces of strong ammoniacal liniment. It had been poured down its throat by another child of five years of age. A solution of strong ammonia has been maliciously used for throwing on the person. It must be regarded as a corrosive liquid, capable of producing serious injury.

Carbonate of Ammonia.—The solution of this salt (sal volatile) is probably more active as a poison than is commonly supposed. The following case occurred to my knowledge in 1832. A man, in a fit of passion, swallowed about five fluid-drachms of a solution of sal volatile. In ten minutes, he was seized with stupor and insensibility; but upon the application of stimulant remedies, he recovered. He suffered for some time afterwards, from severe irritation about the throat and gullet. Mr. Iliff has reported the case of a little boy, aged two years, who swallowed about half an ounce of a strong solution of spirits of hartshorn, and in spite of rather severe symptoms recovered in a few days. ('Lancet,' Dec. 1, 1849.)

In a paper above referred to (p. 232), Dr. Barclay relates the case of a girl, æt. 19, who, while in a state of unconsciousness, was made to swallow a quantity of hartshorn. She felt a severe pain in the stomach immediately, and in about an hour afterwards she vomited some blood. This vomiting of blood continued for several days. These symptoms were followed by great irritability of the stomach, and the constant rejection of food. There was obstinate constipation of the bowels, with great emaciation and loss of strength. She died in about three months from the time at which she had swallowed the alkaline poison. On inspection, the gullet was found healthy; the orifice, at its junction with the stomach, was slightly contracted. The intestinal orifice was contracted to the size of a crowquill, and the coats were thickened. On the posterior wall of the stomach there was a dense cicatrix of the size of half-a-crown, and from this point fibrous bands ramified in various directions. The duodenum and other parts of the intestinal canal were healthy. ('Med. Times and Gazette,' Nov. 26, 1853, p. 554.) A case occurred to Mr. Procter, in May, 1852, in which a woman gave to her infant, four weeks old, a teaspoonful of hartshorn of the strength of about nine per cent. The child became more and more depressed, and died thirty-six hours after taking the liquid. There was no vomiting or purging, and the mouth and throat pre-

seiifed no excoriation; there was, however, slightly increased redness of the lining membrane. An examination after death was not made.

The salts of ammonia are not often used by persons who are intent upon suicide or murder, but there is one instance on record in which a man was tried for the murder of a child by administering to it spirits of hartshorn. (*Regina* v. *Haydon*, Somerset Spring Assizes, 1845.) Of the action of the other compounds of ammonia on man, nothing is known.

Chemical analysis.—The three alkalies, potash, soda, and ammonia, are known from the solutions of the *alkaline earths* by the fact that they are not precipitated by a solution of carbonate of potash. They all three possess a powerful alkaline reaction on test paper, which, in the case of ammonia, is easily dissipated by heat. Ammonia is immediately known from potash and soda by its odour and entire volatility. The *Carbonate of Ammonia* may be known from other salts by its alkaline reaction, its odour, and its entire volatility as a solid:—from pure ammonia, 1, by its effervescing on being added to an acid; 2, by its yielding an abundant white precipitate with a solution of chloride of calcium; from the carbonates of potash and soda, among other properties,—1, by its giving no precipitate with a solution of the sulphate of magnesia; 2, from the rich violet-blue solution which it forms when added in excess to a solution of sulphate of copper; 3, by its odour and volatility.

CHAPTER 18.

POISONING BY NITRE, SULPHATE OF POTASH, AND IODIDE OF POTASSIUM—CHLORIDE OF BARIUM—CARBONATE OF BARYTA.

NITRATE OF POTASH. NITRE. SALTPETRE.

Symptoms and Appearances.—This well-known salt has on several occasions destroyed life, but only when taken in large doses. Three deaths from this salt are recorded to have taken place in four years—1863–7. In a case which is reported by Orfila, a lady swallowed, by mistake for other salts, an ounce of the nitrate of potash. In a quarter of an hour there was vomiting and purging, the muscles of the face were convulsed, the pulse was weak, the respiration difficult, and the limbs were cold; and there was a sense of burning heat and severe pain at the pit of the stomach. She died in *three hours*. On inspection, the stomach was found highly inflamed, and the membrane detached in various parts. Near the pylorus, the inflammation had a gangrenous character. A large quantity of bloody liquid was found in the stomach. (i. 283.) In another case, which proved fatal in sixty hours, where an ounce and a half of nitre had been taken, a small perforation was found in the stomach. (Ib.) The late Dr. Geoghegan met with the following case:—A man took from an ounce to an ounce and a half of nitre by mistake for salts. Severe pain in the abdomen followed, with violent vomiting, but no purging so far as could be ascertained. He died in about *two hours* after taking the salts. On examining the body, a bloody mucus was found in the stomach, the lining membrane was of a brownish-red colour, generally inflamed, and in parts detached from the coat beneath. None of the poison could be detected in the stomach; but its nature was clearly established from the analysis of a portion left in the vessel which had contained the draught. Two men swallowed, each, one ounce of nitre by mistake for Glauber's salt. They almost immediately experienced a sense of coldness in the course of

the spine, trembling in the limbs, with violent vomiting and purging. The evacuations were bloody. They recovered in the course of a few days. (Casper's 'Wochenschrift,' 1841, No. 18.) A case is reported in the same journal, in which one ounce of nitre killed a man in thirty-six hours. In another case an old man, æt. 60, lost his life from an overdose of nitre which he had taken as a medicine. The dose amounted to about ten drachms: it caused profuse purging, and death in about five hours. Death was referred to inflammation of the mucous membrane of the stomach and bowels, owing to the irritant action of the nitre. A female, æt. 28, swallowed in two doses, taken on two days, about an ounce of nitrate of potash. After the second dose, she was attacked with severe burning pain in the stomach, and violent vomiting followed by collapse. There was no purging, and the secretion of urine was arrested. The girl recovered in a few days. ('Pharm, Journal,' Feb. 1846, p. 356.) Mr. Gillard met with a case in which a man recovered in four days after having swallowed two ounces of nitrate of potash by mistake for Epsom salts. In about five minutes after taking the nitre, he felt a burning pain in his stomach, and this was immediately followed by sickness. Free vomiting was excited by mustard; this probably led to his recovery. ('Prov. Med. Journ.' Aug. 19, 1846, p. 382.)

There appears to be some uncertainty in the action of this salt, both as to the symptoms and the fatal effects on the body. Mr. Fuller, of Oswestry, communicated to me a case which proved fatal in December 1863. A man swallowed an ounce of nitre, mixed with water, by mistake for Epsom salts about nine o'clock in the morning. It produced vomiting with severe pain, but no purging. There was coldness of the surface and lividity of the face. Death took place in three hours. On inspection the mucous membrane of the stomach was found highly inflamed, especially towards the middle of the greater curvature, where for several inches it resembled scarlet cloth. The pylorus and duodenum were of a deep crimson colour. The peritoneal surface was very vascular, especially over the stomach, the vessels having a vermilion red colour, as if they had been injected. The heart and lungs were healthy, the blood was fluid and more florid than natural. The other organs presented no unusual appearance. No analysis was made of the contents of the stomach, but that the nitre was the cause of death no doubt could be entertained, and a verdict was returned accordingly at the coroner's inquest.

Analysis.—For the chemical properties and method of detecting this salt, see p. 220.

SULPHATE OF POTASH. · SAL POLYCHREST. SAL DE DUOBUS.

Symptoms and Appearances.—A lady, about a week after her delivery, took, by the prescription of her medical attendant, about ten drachms of the sulphate of potash in divided doses, as a laxative. After the first dose, she was seized with severe pain in the stomach, nausea, vomiting, purging, and cramps in the limbs. These symptoms were aggravated after each dose: she died in *two hours*. It was supposed that some poison had been taken by mistake; but that was not the case, and the question was, whether her death was or was not caused by the sulphate of potash. On an inspection of the body, the mucous membrane of the stomach and intestines was pale, except in the valvulæ conniventes (folds), in which it was reddened. In the stomach was a large quantity of a reddish-coloured liquid, which, on analysis, was found to contain only sulphate of potash, and no trace of any common irritant poison. The examiners referred death to sulphate of potash taken in an unusually large dose, whereby it had acted as an irritant poison on a person whose constitution was already much debilitated. ('Ann. d'Hyg.' Avril 1842.)

The question whether this is to be regarded as an irritant poisonous salt or not, was much debated among members of the profession, in reference to a case which was tried at the Central Criminal Court in October 1843. (The *Queen* v. *Haynes*.) The accused had given to the deceased, the night before her death, two ounces of sulphate of potash, dissolved in water; and it was alleged that a fortnight previously to this she had taken, in divided doses, as much as a quarter of a pound of the salt. The woman thought that she was pregnant, but this was disproved by an examination of the body; and it was charged that the prisoner had given her the salt with the intention of causing a miscarriage. After the last dose, she was seized with sickness, and died within a very short time. The stomach was found empty, but highly inflamed; and there was blood effused on the brain. One medical witness referred death to the action of this salt as an irritant poison; the other to apoplexy, as an indirect result of the violent vomiting caused by it. The prisoner was acquitted of the charge of murder, but subsequently found guilty of administering the sulphate with intent to procure abortion. Both of the witnesses admitted that, in small doses, the salt was innocent; but that in the dose of two ounces, it would produce dangerous effects. A case, somewhat similar in its details, was the subject of a trial at the Central Criminal Court in October 1856. (*Reg*. v. *Gaylor*.) A married woman, the wife of the prisoner, under the belief that she was pregnant, took a large quantity of this salt, the prisoner having purchased two ounces, and handed it to her. It was taken with the design of procuring abortion, but it caused the death of the woman under symptoms of severe irritation of the stomach and bowels. The deceased was not seen by a medical man while living, but she suffered from severe pain, vomiting, and purging: the vomited matter had a bilious colour. On inspection, the stomach and the upper portion of the small intestines were of a deep purple colour, as if from the action of some irritating substance. The stomach when opened, showed marks of irritation and its mucous coat was much congested. In this organ there was a spoonful of a thick, slimy fluid, which contained a quantity of sulphate of potash. The intestines contained twelve ounces of a thick white fluid, highly charged with mucus, and this when analysed yielded sulphate of potash. There was no doubt that death had been caused by an overdose of this salt.

According to Mr. Mowbray ('Medical Gazette,' vol. 33, p. 54), sulphate of potash is much employed in France as a popular abortive. He quotes several instances in which, in large doses, it produced severe symptoms, resembling those of irritant poisoning, and even death. In one case, two drachms acted powerfully; and in another that fell under his own observation, four drachms of the salt administered to a lady after her confinement, had all the effects of an irritant poison. The above cases are the only instances in which, I believe, it is publicly known to have proved fatal in England; and they show that substances, commonly regarded as innocent, may sometimes give rise to important questions in toxicology.

There is no doubt that the most simple purgative salts may, under certain circumstances, and when given in large doses, destroy life. A case is elsewhere related, in which sulphate of magnesia caused death, and gave rise to a criminal charge in this country. ('On Poisons,' 2nd ed. p. 4.) It is said that sulphate of potash has in some cases caused vomiting and other serious symptoms, from its containing as impurity sulphate of zinc. This, if present, would be easily discovered by the appropriate tests. A more serious impurity has been lately detected in it by M. Bussy, namely the arseniate of potash. He found this poison in a sample of sulphate, supplied by a wholesale house in Paris. ('Pharm. Jour.' May 1872, p 954.) This impurity may be derived from arsenical sulphuric acid used in its manufacture. It would be proper to

test for arsenic any sample of sulphate which has caused great irritation. (See ARSENIC.) Arsenic may thus find its way into all medicines in which sulphate of potash is used, *e.g.* the compound colocynth pill and the compound powder of ipecacuanha.

Other impurities of a poisonous nature have been occasionally found in this salt. The reader will find a full account of these by M. Chevallier in the 'Annales d'Hygène,' for 1872, 2, 137.

Chemical Analysis.—Sulphate of potash is easily identified. It is a dry hard salt, soluble in water, forming a neutral solution. This solution, if sufficiently concentrated, is precipitated both by tartaric acid and perchloride of platinum, whereby potash is indicated; and the presence of sulphuric acid is known by the action of a salt of barium (p. 214). *Organic liquids.*—This salt being insoluble in alcohol, may have the organic matter removed from it by treating the liquid containing it (previously concentrated) with alcohol:—or the substance containing the salt may be evaporated to dryness and incinerated, when the undecomposed sulphate may be obtained by lixiviating the calcined residue with distilled water. The sulphate of potash exists naturally in some animal fluids, but only in traces.

IODIDE OF POTASSIUM.

Symptoms.—This salt is extensively employed as a medicinal preparation, but it appears to have given rise, in some instances, to alarming symptoms, even when exhibited in small doses; and it is stated that death has resulted from its use. The following cases may serve to illustrate its alleged noxious effects. A gentleman was ordered by his physician to take three grains of the iodide in a draught of peppermint-water three times a day. After the third dose he felt unwell, and an hour after the fourth dose he was attacked with a violent shivering fit, followed by headache, hot skin, intense thirst, quick and full pulse, with vomiting and purging. These symptoms were succeeded by great prostration of strength. In spite of treatment, the purging lasted several days. The effects of the medicine in this case were so violent, although only *twelve grains* had been taken, that there is little doubt, if the patient had taken another dose, he would have died. ('Med. Gaz.' Sept. 3, 1841.) In October 1841, a case was reported by Mr. Erichsen to the University College Medical Society, in which alarming symptoms resulted from a dose of only *five grains* of iodide of potassium. There was great difficulty of breathing, discharge from the eyes and nostrils, inflamed conjunctivæ, and most of the violent symptoms of catarrh. The iodide was discontinued, and the patient recovered. Dr. Lawrie found that seven grains and a half of the iodide, in three doses, produced in an adult dryness and irritation of the throat, great difficulty in breathing, and other serious symptoms. In another instance, thirty grains, in divided doses, caused severe headache and secretion of tears. In two instances, wherein he had prescribed it medicinally in small doses, it was, in his opinion, the cause of death. ('Med. Gaz. 27, p. 588.) These cases show the necessity of caution in the medicinal use of this substance. The effects from small doses may, perhaps, be attributed to idiosyncrasy; still there seems to be good ground, from the results of experiments on animals, for ranking iodide of potassium among noxious irritant substances. It has not, so far as I know, caused death, if we except the two cases recorded by Dr. Lawrie. One drachm and a half of the solution has been taken by a young female without destroying life, although it produced serious symptoms of irritation. (Devergie, 'Méd. Lég.' ii. 536.) It has been suggested that the occasional adulteration of the iodide with carbonate of potash may account for the discrepant statements respecting its poisonous properties. In one instance, in which the medicinal dose had been carried to

several drachms, the iodide was found to contain 75 per cent. of the carbonate of potash. This may explain the fact that large doses of the iodide have been given by French surgeons in the treatment of syphilis without producing injurious consequences. M. Payen has prescribed as much as 60 grains a day in divided doses, and M. Ricord is stated to have carried the dose to 135 grains in a day. Another theory, however, may be adopted to account for the innoxious character of these large doses. A state of tolerance may have been set up as in the administration of tartar emetic in cases of pulmonary disease.

Chemical Analysis.—The iodide may be distinguished by its cubic crystals and by its solution producing a blue colour with starch on the addition of strong nitric acid. The salt gives a violet colour to flame, indicative of potash, and yields iodine when treated with sulphuric acid and oxide of manganese.

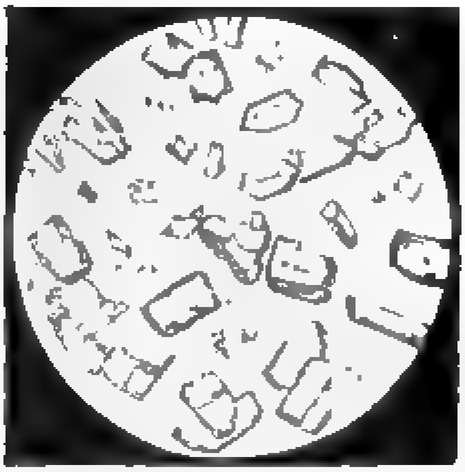
Salts of Barium.

Chloride of Barium.—*Symptoms.*—A woman, æt. 23, took by mistake for Epsom salts less than a teaspoonful (100 grains) of the chloride. This was at 12.30, October 1, 1858. In half an hour there was a feeling of deadly sickness, with sharp burning pains in the stomach and bowels. Vomiting and purging set in violently, the purging being attended with straining. An hour and a half after she had taken the poison the following symptoms were observed by Mr. Walsh. Face pale and anxious, eyes deeply sunk, surface cold, heart's action feeble, pulse scarcely perceptible, tongue natural and warm, loss of muscular power, sensation and intelligence not affected, pupils natural. Fluids taken were instantly rejected with a ropy mucus. There was pain in the stomach, singing in the ears, twitching of the face, and twisting of the legs and arms. At 9 P.M. the symptoms had abated, but at 2 A.M. (*i.e.* in about fourteen hours) the purging had returned, and the symptoms were much worse. There was a loss of voluntary muscular power. The breathing was slow and laboured, and indicated effusion in the bronchial tubes, but the woman was sensible. Soon after 3 A.M. she was convulsed, and these convulsions continued in paroxysms for two hours, when she died, seventeen hours after taking the poison. During the fits she had several watery evacuations, and consciousness was lost. There was no *post-mortem* examination. ('Lancet,' 1859, 1, 211.) A case of poisoning by this salt is reported by Wildberg. The symptoms were those of irritation, combined with an affection of the brain and nervous system. Giddiness, convulsions, and paralysis have been remarked among them. In the case referred to, half an ounce proved fatal in two hours: in another instance, one ounce taken by mistake for Glauber's salt, destroyed life in *an hour*. In small doses, even, the chloride has been observed to affect the system powerfully. Orfila found that the chloride of barium was absorbed: he detected it in the liver, spleen, and kidneys of animals poisoned by it. ('Ann. d'Hyg.' 1842, 2, 217.) A fatal case of poisoning by *Nitrate of baryta*, taken in mistake for sulphur, is reported in the 'Pharmaceutical Journal' for 1869, p. 181. Another fatal case is recorded in the same journal for June 1872, p. 1021. It appears that the salts of barium are used for sizing cotton warps. A man employed in this work swallowed a portion about the size of a bean, thinking he was taking Epsom salts. He died in about fourteen hours. The symptoms were at first those of irritant poisoning, but in the latter stage paralysis took place. The medical witness stated that he had found twelve grains of these salts sufficient to kill a dog.

The *Carbonate of baryta* is said to have destroyed life in two cases, in each of which only one drachm was taken; but the following case, which occurred to Dr. Wilson, shows that this compound is not so poisonous as the chloride. A young woman swallowed half a tea-cupful of the powdered carbonate, mixed

with water, at a time when she had been fasting twenty-four hours. There was no particular taste. In two hours she experienced dimness of sight, double vision, singing in the ears, pain in the head, and throbbing in the temples, with a sensation of distension and weight at the pit of the stomach. There was also palpitation of the heart. After a time she complained of pain in the legs and knees and cramps in the calves. She vomited twice a fluid like chalk and water. The skin was hot and dry, the pulse frequent, full, and hard. These symptoms gradually abated, and she recovered, although the pain in the head and stomach continued for a long time. ('Med. Gaz.' vol. 14, p. 448.) The carbonate is used as a poison for rats and mice.

Fig. 10.



Crystals of Chloride of Barium, magnified 30 diameters.

Analysis.—Chloride of barium crystallizes in thin plates: it is soluble in water. 1. The solution yields an insoluble white precipitate with sulphuric acid or an alkaline sulphate. This precipitate is insoluble in nitric acid. 2. The powdered salt, burnt on platinum-wire in a smokeless flame, imparts to it a greenish-yellow colour. 3. Chlorine may be detected by a solution of nitrate of silver. (See p. 222.)

Carbonate of baryta is a white insoluble powder. It is entirely dissolved with effervescence (carbonic acid) by diluted hydrochloric acid. On evaporation, it yields crystalline plates of the chloride of barium, which may be tested by the processes above mentioned.

CHAPTER 19.

PHOSPHORUS—SYMPTOMS AND APPEARANCES—CHRONIC POISONING BY THE VAPOUR—FATAL DOSE—CHEMICAL ANALYSIS—PHOSPHORUS-PASTE—RED OR ALLOTROPIC PHOSPHORUS—IODINE.

Poisoning with phosphorus is not very frequent in this country; but in France, according to Tardieu, this poison is often selected for the purposes of suicide or murder. In England, within a period of four years, there were fifteen deaths from phosphorus out of 1620 cases of poisoning. In France, within a period of six years, there were 108 cases of poisoning with phosphorus which gave rise to medico-legal inquiry.

Phosphorus is not often used in this country in attempts at murder. The smell and taste as well as luminosity commonly reveal its presence. At the Norwich Autumn Assizes, 1871 (*Reg.* v. *Fisher*), a girl of eighteen was convicted of an attempt to poison a family. She put a vermin compound of phosphorus into a teapot containing tea. When hot water was poured on it, the smell at once led to suspicion. Phosphorus was found in it, taken from a pot carelessly left about the house. The girl was convicted, and sentenced to penal servitude for life. The late Professor Casper of Berlin describes a case in which the luminous appearance of the poisoned food led to a suspicion of poisoning with phosphorus, and this was subsequently proved. A woman put a preparation of phosphorus into some soup, and gave it to her husband. He ate it in a dark room in the presence of some friends, and they noticed that the liquid as he stirred it was luminous ('Vierteljahrsschrift,' July 1864). In this way a person may be warned and a life saved (see 'Ann. d'Hyg.' 1870, 2, 203).

Symptoms.—Phosphorus acts as an irritant poison, but its operation is attended with some uncertainty, according to the state in which it is taken. The symptoms are frequently slow in appearing: it is only after some hours, and sometimes even one or two days, that signs of irritation with convulsions and spasms appear; but when these once come on, the case proceeds rapidly to a fatal termination. In the first instance the patient experiences a disagreeable taste resembling that of garlic, which is peculiar to this poison. An alliaceous or garlic odour may be perceived in the breath. There is an acrid burning sensation in the throat, with intense thirst, nausea, severe pain and heat with a pricking sensation in the stomach, followed by distension of the abdomen and frequent vomiting with occasional purging. The vomited matters are black or of a dark brown (coffee-ground) colour, and have the odour of garlic: white vapours having the peculiar odour of phosphorus may be seen to proceed from them, and in the dark they may even appear phosphorescent. The pulse is small, frequent, and scarcely perceptible. There is great prostration of strength, and coldness of the skin, with other symptoms of collapse. The patient may die quietly in a state of coma, or be convulsed before death. Jaundice has been observed among the symptoms.

A woman, æt. 26, swallowed a decoction of lucifer-matches in coffee. In an hour an emetic was given to her, and she vomited half a pint of clear glairy fluid, having the smell of phosphorus, and containing particles of blue colouring matter (Prussian blue) derived from the matches. She had no pain in the stomach, and no purging. In four days she appeared to have recovered; but about this time there was bleeding from the nose; she was jaundiced, and blood appeared in the matter vomited. Febrile symptoms set in with purpura, and she died in about a week after taking the poison. ('Ed. Monthly Journal,' Oct. 1860.) On April 20, 1861, a girl swallowed a quantity of phosphorus-paste. When seen soon afterwards by Mr. Parsons of Bridgewater, her lips as well as parts of her dress were smeared with this substance, and there was a strong odour of phosphorus in her breath. Her countenance was tranquil: her pulse regular: there was no sickness or nausea, and she complained of nothing but slight thirst. Her symptoms were so slight that they excited no suspicion that the girl had swallowed the poison. She passed a restless night, and the next day she complained of heat in the mouth and throat, and of a slight sensation of nausea and retching. There was no pain or tenderness in the region of the stomach, the pulse was regular but weak. On the 22nd she dressed herself and was able to walk about the ward: she left the hospital and went home, having walked a mile: she had her tea as usual at night, and went to bed. On the following day, the 23rd, she complained of pain in her bowels, with sickness and purging. These symptoms became worse. On the 25th there was pain in the bowels, which were tender on pressure and slightly tympanitic. The pulse was intermittent, and the girl was fast sinking. She died on the 26th, having survived the effects of the poison nearly a week, and no well-marked symptoms having set in until the *fifth day*. An inspection of the body was not permitted, and the only fact observed after death was a tendency to rapid putrefaction. The whole of the body became speedily livid, and the finger-nails were blue—a condition noticed by a witness to have existed before death. (For other cases, see 'Ann. d'Hyg.' 1869, 2, 397.)

It will be perceived that, in reference to the delay in the appearance of symptoms, their slightness taken as a whole, and the time at which death occurred, this case is similar to the one previously related. If it were not for the peculiar character of the circumstantial evidence, these cases might easily throw a practitioner off his guard in forming an opinion. The odour of the

breath, and the appearance of phosphorus smeared over the dress, first attracted the notice of Mr. Parsons. Other witnesses deposed that whatever deceased touched with her hand seemed to take fire, and that when she drank water to allay her thirst, a kind of smoke issued from her mouth. Her hands and dress were luminous in the dark.

Phosphorus-vapour. Chronic-poisoning.—Chronic poisoning by phosphorus is accompanied by nauseous eructations, frequent vomiting, a sense of heat in the stomach, purging, straining, pains in the joints, wasting, hectic fever, and disease of the stomach, under which the patient slowly sinks. Some interest is attached to the chronic form of poisoning by phosphorus from the researches of Dr. Strohl and others, on the effects of the *vapour* upon persons engaged in the manufacture of phosphorus- or lucifer-matches. It has been remarked that such persons have suffered from necrosis of the jaw, carious teeth, and abscesses. There has been also great irritation of the respiratory organs, and bronchitis has frequently shown itself among them. These effects have been attributed to the respiration of the vapours of phosphorus, which are supposed, in becoming acidified, to act chemically upon the exposed portions of the teeth. (See 'On Poisons,' 2nd edit. p. 345.)

Appearances.—Among the appearances produced by this poison are marks of irritation, inflammation, and ulceration in the stomach and intestines. The stomach has been found much contracted, and its mucous membrane inflamed, occasionally softened and presenting purple or violet-coloured spots. Inflammation of the stomach and bowels proceeding to gangrene, may be a result of the action of phosphorus. M. Worbe found the stomach perforated in three places in a dog which had been poisoned by a solution of phosphorus in oil. A man, æt. 50, took a quantity of phosphorus-paste used for destroying vermin. He was seen in his usual health at 12 o'clock at noon, and was found dead in a field the following morning. On inspection, it was observed that there was great muscular rigidity. The membranes of the brain were congested, and there was serous effusion between them. The substance of the brain was also congested. The heart was flaccid and nearly empty. The mucous membrane of the stomach, gullet, and small intestines was very red, and there were patches in which the membrane was destroyed. On opening the stomach a white vapour escaped, accompanied by a strong smell of phosphorus. This organ contained a tablespoonful of a viscid greenish matter, from which particles of phosphorus with some Prussian blue (used as a colouring for the poison), subsided on standing. (Dr. Bingley, 'Lancet,' June 13, 1857, p. 600.) (See al a case by Dr. Kessler, Horn's 'Vierteljahrsschrift,' 1866, 1, 271.) In a case ex amined by the late Mr. Herapath, he found, besides inflammation of the stomac the mucous membrane raised in small bladders or vesications. This was probabl a change produced by putrefaction, as the body was not examined until twenty three days after death. Such an appearance is frequently seen in the inspec tions of putrefied bodies, and has not been observed in cases of recent poisonin by phosphorus. Schuchardt describes, among the appearances, fluidity of th blood, which is of a dark colour, and does not become red on exposure to th air. Another remarkable appearance frequently met with is a fatty chang in the liver and other soft organs. Ecchymoses are sometimes found on th skin and on the surface of various organs. ('Brit. and For. Med. Rev.' 185 19, 506 'Journal de Chimie médicale,' 1857, p. 84.)

In the case of the female described at p. 243, who died after the lapse of week, there was no inflammation, ulceration, or softening of the mouth, gulle stomach, or small intestines. There was a red patch in the cæcum, and anothe in the colon (the large intestines). The contents of the stomach and inte tines had a coffee-ground colour, like the liquid found in hæmatemesis (vomit ing of blood). The brain was slightly congested. There were bloody effusion

in the chest and abdomen, and an apoplectic condition of the soft organs. The vomited matters, when shaken in the dark, were luminous, and phosphorus was separated from them by sulphide of carbon. The viscera, and even the flesh of animals recently poisoned by phosphorus, have the odour of garlic, and appear luminous in the dark. (Galtier, 'Toxicologie,' vol. 1, p. 184.) Mr. Clowes informed me, that in examining some fowls which had been poisoned by phosphorus, he was struck with the strong odour of this substance on opening the gizzards, and with the appearance of a fine white fume, which was luminous when observed in a dark room. In the case of a woman who died while taking phosphorus medicinally, it was remarked that the whole of the viscera of the body were luminous in the dark; thus indicating the extensive diffusion of the poison by absorption. (Casper's 'Wochenschrift,' Feb. 21 and 28, 1846, pp. 115, 135.) For a further account of the appearances, see 'Chemist,' Jan. 1856, p. 244. In one case which I examined in 1867, that of a girl, æt. 13, who died on the sixth day after taking phosphorus-paste beaten up with egg, there were the usual symptoms, with severe paroxysms of vomiting and pain. The matters first vomited were observed to be luminous in the dark. There were numerous ecchymosed patches in the cellular tissue of the skin of the abdomen over the rectus muscle; these were also seen on the chest and on the diaphragm. The stomach contained a dark-coloured thick fluid like altered blood; the coats were not inflamed; the surface of the inner coat was covered with a brownish-coloured mucus which had no odour of phosphorus. At the greater curvature the surface was dotted over with numerous small dark particles, consisting of coagula of altered blood adhering to the membrane, but easily removed from it. They had the appearance of effused coagula of blood in petechial spots. The contents of the stomach owed their colour to these little masses of blood being diffused through them. The duodenum contained a similar liquid. The intestines presented no abnormal appearance. The liver was in an advanced state of fatty degeneration. This condition of the liver has occurred so frequently in cases of phosphorus-poisoning, that it may now be regarded as one of the characteristic appearances. ('Guy's Hospital Reports,' 1868, p. 242.) M. Tardieu has met with this fatty degeneration in poisoning with phosphorus, not only in the liver, but in the heart and kidneys ('Étude Méd-Lég. sur l'Empoisonnement,' 1867, p. 441.) In this work the reader will find a complete history of this form of poisoning.

In an interesting case recorded by Dr. Habershon ('Med. Chir. Trans.' 1867, vol. 50), in which a woman died on the fifth day, the symptoms and appearances were similar to those above described. The phosphorus was taken in the form of paste, and it is supposed in a dose of from three to four grains. There was much ecchymosis in patches in and about the cellular tissue of the abdomen and chest. There was fatty degeneration of the liver and kidneys. The stomach contained a large quantity of fluid like soot and water, and was covered with a tenacious bloody mucus. There was some congestion in the mucous membrane, but there was much redness with ecchymosis in the small intestines. (For further information on this subject, see 'Die acute Phosphor-Vergiftung von Munk und Leyden,' Berlin, 1865. Horn's 'Vierteljahrsschrift,' 1866, 1, 271, and Wiggers and Husemann's 'Jahresbericht' for 1872, p. 472).

Fatal dose.—That phosphorus is a powerful poison, is proved by two cases quoted by Sir R. Christison. In one, death was caused by a grain and a half in twelve days; in the other, by two grains in about eight days. It has been supposed to operate as a poison only by becoming converted into phosphorous acid; but although this conversion takes place, it is probable that phosphorus passes directly into the blood, since the urine voided during life has been observed to be luminous: hence it is itself probably a blood-poison. The production of phosphorous acid, by its oxidation, may account for the

erosions met with in the stomach and bowels. Dr. Hartcop mentions that an apothecary took by way of experiment one grain; on the next day two grains, and on the third day three grains of phosphorus, mixed with sugar. He was then seized with inflammation of the stomach and bowels, and died in spite of every attempt to save him. (Casper's 'Wochenschrift,' 1846, p. 117.) M. Chevallier refers to a case in which a dose of 2·3 grains proved fatal, and two other cases in each of which a dose of 4·6 grains destroyed life. The same writer quotes, on the authority of Löbenstein Löbel of Jena, the case of a lunatic who died from a dose of one-eighth of a grain. ('Ann. d'Hyg.' 1857, 1, 422.) Excepting this, the smallest fatal dose which I have met with, is in a case quoted by Galtier. A woman, æt. 52, took in divided doses, in four days, about six centigrammes, or less than *one grain*, of phosphorus dissolved. The largest dose taken at once, *i.e.* on the fourth day, is stated to have been three centigrammes (0·462 grain), or less than half a grain. Symptoms of pain and irritation appeared, and the patient died in three days. The gullet, stomach, and small intestines were found much inflamed. ('Toxicologie,' vol. 1, p. 87.) When the phosphorus is dissolved in any liquid, or when it is finely divided, as in phosphorus-paste or in lucifer-matches, its action is then more powerful, as it is in a state well fitted for absorption.

Period at which death takes place.—This has varied greatly, in the cases hitherto observed, from a few hours to a week. In a case related by Orfila death took place in four hours. In another also related by him death occurred only after seventeen days. Dr. Habershon quotes a case which is said to have proved fatal in half an hour. ('Med. Chir. Trans.' 1867, vol. 50.) This is the shortest period recorded. In general, several days elapse before a fatal result occurs, and during this time the patient undergoes much suffering. This was observed in a young woman who swallowed a quantity of phosphorus-paste intended for poisoning rats. She did not die until the fifth day. ('Journal de Chimie Méd.' 1845, p. 580.) In two cases of acute poisoning with phosphorus communicated to me by the late Dr. W. D. Moore, one proved fatal in seventy-two, and the other in eighty-eight hours. The symptoms and appearances were similar to those already described. Fatty degeneration of the liver and other organs was especially marked. (See 'Medical Press,' Nov. 15, 1865, p. 434.) In a case which occurred to Dr. Anderson, a child aged one year and eight months had sucked the heads off about twenty phosphorus-matches before it was detected. No symptoms appeared until the second day, when the child was drowsy and slept for twenty hours. Castor oil and oil of turpentine were given. On the fourth day it vomited, the skin was hot, tongue dry, there was great thirst with a quick pulse and cold extremities. On the sixth day there was much vomiting of a matter like coffee-grounds (altered blood). There was great pain in the stomach—the child became unconscious and gradually sank, dying on the seventh day after taking the poison. There was no purging, but the motions were passed involuntarily, containing coagulated blood. An alliaceous odour was perceived in the breath during the progress of the case, and the body had a yellowish (icteric) tint. On inspection there was marked general ecchymosis. The liver was enlarged, and of a yellowish colour, undergoing fatty degeneration. The lining membrane of the stomach was injected, and it contained a dark bloody fluid. There was no odour of phosphorus, and the contents were not luminous in the dark. Phosphorus could not be detected by Mitscherlich's process. ('Lancet,' 1871, 2, 189.)

Chemical analysis.—Phosphorus is a solid of waxy consistency, having a peculiar odour and taste resembling garlic. It is the odour and taste which prevent it from being criminally employed as a poison, and render it easy of detection in articles of food. It evolves a white vapour in daylight, and a

faint bluish luminosity in the dark. It melts and takes fire at a temperature of 113°, burning with a bright yellow flame, and producing thick white acid vapours by combustion. It is not soluble in water, but water in which it has been preserved or washed, acquires poisonous properties by reason of the phosphorous acid formed. ('Ann. d'Hyg.' 1857, 1, 423.) It is dissolved by alcohol, ether, chloroform, and the oils, but especially by sulphide of carbon.

Organic liquids.—The smell which phosphorus imparts to organic substances is remarkably characteristic. If the smell is not perceptible, or if concealed by other odours, the liquid supposed to contain the phosphorus may be heated in a flask in the dark, when if phosphorus is present a garlic odour will be perceived and the vapours may appear feebly luminous as they are condensed in the air. When phosphorus has been taken in a solid form, the particles may be separated as a sediment, by washing the contents of the stomach in water. These may be melted under water into one mass, either by plunging the tube containing them into hot water, or by pouring hot water upon them in a conical glass. If a portion of the organic liquid is evaporated to dryness in the dark, the particles of phosphorus will be easily recognised by their luminosity, as well as by their combustion when the surface on which the material is spread is further heated. Phosphorus is very soluble in sulphide of carbon, and it may be separated from many organic matters by digestion with this liquid. It is thus procured from flour and phosphorus-paste, or from the residue of the contents of the stomach after washing and decantation. On the spontaneous evaporation of the sulphide, decanted from the organic liquid or solid, the phosphorus may be procured in small globules or beads. These are ignited when touched with a hot wire. A portion of the solution poured upon thin paper, ignites spontaneously when dry, and burns with the well-known flame.

If the phosphorus is in a state of solution, or is in too small quantity to be dissolved out of the material by sulphide of carbon, its presence may be indicated by distilling the liquid containing it in the dark—the boiling point being raised by the addition of sulphuric acid. The vapour appears luminous as it is condensed in a glass condensing-tube. So delicate is this process of distillation, which was first suggested by Mitscherlich, that in one experiment with the head of a single lucifer-match the luminosity appeared for half an hour in the condensing-tube. The most absolute darkness is required for the success of this experiment.

If the person has survived several days, it is not likely that any free phosphorus will be found in the stomach or its contents. None was found in the contents of the stomach or in the fatty liver of the girl who died on the sixth day (page 245), but the distillation-process succeeded with the broken top of a pot which had held the phosphorus-paste, although this was empty and had been thrown into a tub of water. In Dr. Habershon's case of death on the fifth day, none was found by Dr. Stevenson in the stomach or contents. The phosphorus in these cases is oxidized rapidly, and thus, like other poisons, it may disappear from the body. Under these circumstances it may, according to some authorities, be still discovered as phosphoric acid. M. Mialhe has given an elaborate report on a case in which the symptoms and appearances were those of phosphorus-poisoning, the girl dying on the fifth day. Mitscherlich's process failed to show any free phosphorus. Eight weeks afterwards portions of the viscera were examined by MM. Tardieu and Roussin. They found in the intestines and on the liver groups of small crystals of ammonio-phosphate of magnesia, and in the fluid contents an acid liquid having the properties of phosphoric acid. ('Ann. d'Hyg.' 1869, 1, 134.) These crystals, it may be observed, are frequently found as a result of decomposition in the stomach or

the liver, kidneys, and other organs, without reference to poisoning by phosphorus. As the phosphates are found in the secretions, which are generally acid, it would be difficult to satisfy an English Court that their presence proved poisoning by phosphorus, unless the symptoms, appearances, and circumstantial evidence were so strong that chemical evidence was scarcely necessary.

In a case which occurred to Mr. Herapath, this chemist failed to detect any trace of phosphorus in a body on the twenty-third day after death.

Phosphorus readily undergoes oxidation in the body, and is thus converted into phosphorous or phosphoric acid. M. Blondlot has suggested a process for its detection when this conversion into phosphoric acid has taken place. It depends on a peculiar green colour which the lower oxides of phosphorus give to the flame of nascent hydrogen when burnt. (See 'Journal de Chimie,' 1862, p. 528; also a paper by Dr. Ludwig, 'Journal de Chimie,' 1863, p. 581.) The late Dr. Herapath suggested this some years since as a method of detecting phosphorus thus changed in the body, and he employed it in one medico-legal case. Mr. Barrett has lately shown, by a variety of experiments, that the flame of pure hydrogen is rendered of a vivid green by an infinitesimal trace of phosphorus ('Nature,' April 1872, p. 483), but as phosphates are constituents of most of the solids and fluids of the body, this mode of testing would hardly be applicable to medico-legal purposes. It requires for medico-legal application materials of absolute purity for procuring hydrogen as well as a pure atmosphere and perfect darkness.

When the phosphorus has been scraped from the tops of matches it may be oxidized and lost, but as it is usually coloured with vermilion, Prussian blue, or some other colouring matter, these substances may be found in the washed sediment of the contents of the stomach. On the non-discovery of free phosphorus in the body, these colouring matters, if present, serve to indicate the form in which the poison has been taken or administered. In a case which occurred to Tardieu and Roussin sulphur was found as well as phosphorus. ('Ann. d'Hyg.' 1868, 1, p. 117.) The proportion of phosphorus in matches varies. The dry composition may contain as much as one-fourth of its weight. Phosphorus-paste is said to contain one-eightieth of its weight of this substance. ('Ann. d'Hyg.' 1869, 2, 396.)

Red or Allotropic Phosphorus.—The remarkable substance, known under the name of allotropic phosphorus, is not possessed of poisonous properties. This fact, long since announced by Liebig ('Letters on Chemistry,' 165), has been confirmed by experiments at the Veterinary College at Alfort. ('Ann. d'Hyg.' 1857, 1, 432.) Common phosphorus is poisonous in doses varying from one to three grains, while allotropic phosphorus has been given to animals in doses of thirty grains without causing symptoms of poisoning. This kind of phosphorus, by reason of its being generally in a fine powder, is in a state more favourable for acting as a poison than common phosphorus; and yet, owing probably to its insolubility, it is inert. M. Bussy in 1850, and M. de Vrij in 1851, proved that a dog might take with impunity thirty grains. Orfila and Rigault have given it to animals in doses amounting to some ounces, over a period of twelve days, without producing any noxious effects. (See 'Annuaire de Thérapeutique,' 1855, p. 103.) That it does not act as a poison in the human body, appears to be established by the facts of a case reported in the 'Edinburgh Monthly Journal' for October 1860. A woman, æt. 26, swallowed the composition scraped from a number of lucifer-matches: it turned out that these were made with allotropic phosphorus. She suffered no inconvenience. She procured other matches of common phosphorus, took a decoction of them in coffee, and died from the effects.

Analysis.—Allotropic phosphorus is easily recognized by heating it, or any

mixture containing it, to about 500°, when it burns like common phosphorus, and yields similar products. It is insoluble in all liquids, and by its insolubility in sulphide of carbon, it is distinguished and separated from common phosphorus. It has no odour or taste, and is not luminous in the dark, unless it contains common phosphorus. In any analysis for phosphorus, we must take care to exclude it by employing sulphide of carbon as a solvent for the common or poisonous form of phosphorus. (The reader will find a full account of the comparative effects of the common and allotropic phosphorus by M. Chevallier in the 'Annales d'Hygiène,' 1856, 1, 374. See also the same journal, 1859, 2, 370, and Casper's 'Vierteljahrsschrift,' 1860, 2, 185.)

Iodine.

Symptoms.—From experiments on animals, as well as from observation of its effects on man, iodine has a strong local action as an irritant on the stomach and bowels. In large doses, it occasions a burning heat in the throat, severe pain in the abdomen, with vomiting and purging; the vomited matters having the peculiar odour of iodine, and being of a yellow colour, except when any farinaceous food has been taken, in which case they are blue, or even black. The fæcal matters may also contain iodine if the poison has been taken in the solid state. Besides these symptoms, there is great thirst, with anxiety, headache, giddiness, trembling and convulsive movements of the limbs, and fainting; these last symptoms indicating that the poison has become absorbed. When taken for some time in small doses, it gives rise to salivation, vomiting and purging, pain in the stomach, and cramps; the pulse becomes small and frequent; there is a general wasting of the body; and it has been observed that, in this form of chronic poisoning, certain glands are liable to become affected and diminished by absorption—the breasts in the female, and the testicles in the male. Iodine produces these secondary effects (iodism), whether it is taken internally or applied externally. A woman swallowed by mistake one drachm of iodine dissolved in an ounce of alcohol. When seen soon afterwards, she complained of a violent pain in the throat or stomach, followed by retching and slight vomiting; pulse rapid and full; eyes prominent and suffused. Vomiting, promoted by diluents, brought no relief to the symptoms. She became much depressed, and died on the following day. There was no examination of the body. ('Prov. Jour.' June 30, 1847, p. 356.) For a case of recovery from half a drachm, see 'Med. Times and Gaz.' Dec. 28, 1861, p. 669.

Iodine is rarely used as a poison. In May 1864 an attempt was made by a woman to poison a fellow-servant by mixing tincture of iodine with food in a plate. The remarkable discoloration of the farinaceous food which it produced, led to suspicion, and prevented any ill effects from following. Iodine gives a blue, green, or dark colour to most organic liquids, and imparts to them a peculiar odour. It stains the skin and other organic substances yellow; the colour being removed by an alkali. When in strong solution, it is corrosive and destroys the parts which it touches; in this state it has been maliciously employed for throwing on the person.

Appearances.—As this is an irritant as well as a corrosive poison, the lining membrane of the gullet, stomach, and intestines is found inflamed and excoriated. In one instance, the mucous membrane near the pylorus was corroded and detached in a space of two or three inches.

Analysis.—The odour is in general sufficient to identify it. This may be concealed by alkalies or alkaline substances. When heated, it sublimes in a purple vapour. The addition of a cold solution of starch produces a blue colour, but many substances prevent this reaction. It is very soluble in sul-

phide of carbon, forming a rich pink solution. The sulphide has the property of removing it from water or organic liquids in which it is dissolved. It may thus be separated for chemical examination by decanting the watery liquid from the sulphide, which, on evaporation, leaves the iodine in crystals.

METALLIC IRRITANTS.

CHAPTER 20.

ARSENIC—ARSENIOUS ACID—SYMPTOMS—CHRONIC POISONING—APPEARANCES AFTER DEATH—FATAL DOSE—CHEMICAL ANALYSIS—ARSENITES—ARSENIC ACID—ORPIMENT AND OTHER COMPOUNDS.

White Arsenic. Arsenious Acid.—The term White Arsenic is commonly applied to the arsenious acid of chemists. It is seen under the form of a white powder visibly crystalline in a strong light, or when viewed with a lens. It is also met with, but more rarely, in opaque brittle white masses resembling enamel. It is called an acid from its power of combining with alkalies, but it possesses a feeble acid reaction when dissolved in water. It is often described as having an acrid taste, but this does not appear to be correct; a small quantity of it has certainly no appreciable taste, a fact which may be established by direct experiment, and might be inferred from its sparing solubility in liquids. It would appear, from numerous cases on record, that it has been unconsciously taken in fatal quantities, in all descriptions of food, without exciting the least sensation on the tongue. Most of those persons who have been criminally or accidentally destroyed by arsenic, have not been aware of any taste in taking the poisoned substance. In cases in which the powder has been taken in *large* quantity, it is described as having had a *roughish* taste. Water boiled for an hour on the poison and allowed to cool, holds dissolved the 40th part of its weight, or about twelve grains in one ounce. If boiled for a shorter time not more than the 80th part will be dissolved. Cold water allowed to stand for many hours on the poison does not dissolve more than from the 1000th to the 500th part of its weight; *i.e.* one half grain of arsenic to nearly one fluid-ounce of water. When arsenic in powder is mixed with cold liquids, a portion of the powder floats and adheres to the sides of the vessel. This appearance has sometimes led to a suspicion of poisoning.

Arsenic, as it is sold to the public in small quantities, should be mixed either with the 16th part of its weight of soot, which gives to it a greyish colour; or the 32nd part of its weight of indigo, and then it is blue. Both of these colours are rendered much deeper when the powder is wetted, so that the sooty compound is then nearly black. Sometimes, in place of indigo, artificial ultramarine is employed as a colouring. The Act regarding the colouring of arsenic (14 Vic. c. 13, s. 3) is frequently evaded. It is sometimes sold uncoloured under the name of *mercury*.

Symptoms.—These will vary according to the form and dose in which the poison has been administered. The time at which they come on, is generally in from half an hour to an hour after the poison has been swallowed. This is

the average period. I have known them to appear in a quarter of an hour. Sir R. Christison mentions one instance in which the symptoms began in eight minutes; but in the case of *Lofthouse*, tried at the York Lent Assizes, 1835, the symptoms were proved to have attacked the deceased while he was in the act of eating the cake in which the poison was administered. On the other hand, in an instance communicated to me by Mr. Todd, where one drachm had been taken on an empty stomach, no symptoms appeared for two hours; in a case reported by Orfila, the symptoms did not show themselves for five hours; and in another that occurred to Dr. Lachèse, in which a large dose was taken, the symptoms did not come on for seven hours. ('Ann. d'Hyg.' 1837, 1, 344.) Dr. Thompson, of Liverpool, states that he met with a case in which from thirty to forty grains of arsenious acid, and the same quantity of chrome yellow, were taken. Symptoms of poisoning did not appear until five or six hours afterwards. ('Med. Chir. Rev.' Jan. 1854, p. 294.) There may be every variety between these extremes. In one case their appearance was protracted for *ten* hours, the maximum period yet known. A remarkable instance occurred to M. Tonnelier, in which the poison was taken by a young female at eleven o'clock in the morning, and no well-marked symptoms occurred for *eight hours*: there was then violent vomiting. After death, a cyst, formed of mucous membrane containing arsenic, was found in the stomach: the poison having thus become sheathed over! ('Flandin,' vol. 1, p. 535.) In a case communicated by Mr. Clegg to the 'Medical Times' (Oct. 21, 1848), symptoms of violent irritation did not show themselves until twenty-three hours after the poison had been taken, and within about half an hour of the death of the patient. The girl was once sick shortly after having taken the poison, but the first symptoms were those of narcotism. The girl was a confirmed opium-eater, and this habit may have had some influence in delaying the operation of the poison. From a case communicated to the 'Medical Gazette' by Dr. W. Burke Ryan (vol. 47, p. 722), it appears that the active symptoms of irritation which commonly attend arsenical poisoning, may not appear until after the lapse of *nine hours* from the time at which the poison has been swallowed. With the exception of the case above referred to, in which the interval was ten hours, this is the longest period of protraction on record. In other instances there have been great intermissions. In all cases in which arsenic enters the system from without, as by its application to the skin, or to ulcerated or diseased surfaces, the symptoms are rarely manifested until after the lapse of some hours or even days.

10 min to 10 hours

The individual first experiences faintness, depression, nausea, and sickness, with an intense burning pain in the region of the stomach, increased by pressure. The pain in the abdomen becomes more and more severe; and there is violent vomiting of a brown turbid matter, mixed with mucus, and sometimes streaked with blood. These symptoms are followed by purging, which is more or less violent, and this is accompanied by severe cramps in the calves of the legs. The matters discharged from the stomach and bowels have had in some instances a yellowish colour, as it was supposed, from a partial conversion of the poison to sulphuret, but more probably from an admixture of bile. The vomited matters are in some cases coloured with blood, and the mixture of blood with bile has often given to them a green or brown colour. In other cases, they may consist of a large quantity of mucus ejected in a flaky state and having a milky-white appearance, as if from admixture with the poison. The *colour* of the vomited matters may be blue or black when coloured arsenic has been taken, or the admixture of bile may render them of a deep green. The vomiting is in general violent and incessant, and is excited by any liquid or solid taken into the stomach. There is tenesmus

(straining), and the discharges by the bowels are frequently tinged with blood. There is a sense of constriction, with a feeling of burning heat in the throat, commonly accompanied by the most intense thirst. The pulse is small, very frequent, and irregular; sometimes wholly imperceptible. The skin is cold and clammy in the stage of collapse; at other times it is very hot. The respiration is painful from the tender state of the stomach. There is great restlessness, but before death stupor may supervene, with paralysis, tetanic convulsions, or spasms in the muscles of the extremities. In one instance trismus (lock-jaw) appeared in three quarters of an hour. ('Orfila,' vol. 1, p. 449.) Although pain is in general among the early and well-marked symptoms, arsenic appears in some cases to destroy sensibility. Thus it has been observed that, even when the stomach has been found intensely inflamed after death, the patient had not complained of pain during the time which she survived.

Chronic poisoning.—Should the person recover from the first effects, and the case be protracted, or should the dose have been small and administered at intervals, there will be inflammation of the conjunctivæ, with suffusion of the eyes, and intolerance of light, conditions which are, however, often present among the early symptoms above described. In a case reported by Mr. Jeffreys, a woman died in three hours after taking arsenic in a pudding served at dinner. There was no vomiting or purging. In two hours she was in a state of complete collapse, and at the time it was noticed that the conjunctivæ (the membranes of the eyes) were red. ('Med. Times,' Aug. 30, 1851, p. 229.) There is also irritation of the skin, accompanied by a vesicular eruption, which has been called eczema arsenicale. Sometimes this has assumed the form of nettle-rash or of the eruption attending scarlet fever, for which disease arsenical poisoning has been mistaken! Local paralysis, preceded by numbness or tingling in the fingers and toes, and other symptoms of nervous disorder, are also common consequences. Exfoliation of the cuticle and skin of the tongue, with the falling off of the hair, has likewise been witnessed. (Case of the *Turners*, 1815, 'Marshall,' p. 119, Husemann's 'Jahresbericht,' 1871, p. 527.) Salivation has been observed to follow, especially when small doses of the poison have been given for a length of time. ('Med. Gaz.' vol. 16, p. 790.) Strangury and jaundice have been also noticed among the secondary symptoms. ('Marshall on Arsenic,' pp. 44, 111.) A well-marked case of *slow poisoning* by arsenic is recorded by Flandin. ('Traité des Poisons, ou Toxicologie,' tom. 1, p. 510.) It illustrates a not unfrequent form of *secret* murder, and it is well calculated to inspire caution in making a diagnosis from symptoms. A woman put daily into the soup of her fellow-servant, a very small quantity of white arsenic in powder. Shortly after dinner this person was seized with vomiting which led to the rejection of the food and poison before the latter had caused any serious mischief. As this practice was continued at intervals for about six weeks, the stomach became exceedingly irritable; there was pain in the bowels, and the woman was much emaciated. There was also spitting of blood, with such a degree of nervous irritability that a current of air falling upon her, caused an attack of spasms and convulsions. When the patient found that she could not bear anything on her stomach, she left the place and passed two months in the country. Her health became gradually re-established there, and she returned to resume her usual occupations. The prisoner, however, renewed her attempts; and, to make sure of destroying life, gave to her one morning, in coffee, a strong dose of white arsenic in powder: violent vomiting ensued, and the poison was expelled with the food taken at breakfast. Arsenic was detected in the vomited matter, and the explanation of the cause of the long previous illness became clear. Under proper treatment the patient recovered. Such symptoms as thos above described, may be easily referred to chronic inflammation, or ulceration

of the stomach from natural causes, leading to perforation. There are many anomalous cases on record, in which the symptoms have diverged so much from the ordinary course as to embarrass medical practitioners. For some of these, I must refer to a paper by Dr. Ogston, 'Med. Gaz.' vol. 47, p. 181; also to my work 'ON POISONS,' 2nd Ed. p. 363; and Husemann's 'Jahresbericht,' 1872, p. 481.

Arsenic is not an accumulative poison; it is temporarily deposited in the organs after absorption, but is rapidly eliminated by the urine and other secretions; and in two to three weeks, if the person survives, the whole of it may be removed from the body.

Appearances after death.—The striking changes produced by arsenic are generally confined to the stomach and bowels. They are commonly well marked in proportion to the largeness of the dose, and the length of time which the person has survived after taking the poison. Our attention must be first directed to the *stomach*. Arsenic seems to have a specific effect on this organ: for, however the poison may have entered into the system, whether through a wounded, diseased, or ulcerated surface, or by the act of swallowing, the stomach has been found inflamed. The mucous membrane of the stomach, which is often covered with a layer of mucus, mixed with blood or bile, and with a thick white pasty-looking substance containing arsenic, is commonly found red and inflamed in dotted or striated patches: the colour, which is of a dull or brownish red, becomes brighter on exposure to the air: at other times it is of a deep crimson hue, interspersed with black-looking lines or patches of altered blood. The redness is usually most strongly marked at the greater end; in one case it may be found spread over the whole mucous surface, giving to it the appearance of red velvet; in another it will be chiefly seen on the prominences or folds of the membrane. In one instance I found the coats thickened and of a gelatinous consistency, without any marked inflammatory redness.

The stomach has been found highly inflamed in a case which proved fatal in *two hours*. Thus it would appear that inflammation of the mucous membrane may be well marked within a very short period. This is confirmed by a case communicated to me by Mr. Clegg, coroner for Boston; it was the subject of an inquest before him in Sept. 1863. A woman, æt. 24, retired to her bed-room after dinner, at two o'clock, to lie down. At three o'clock she was not suffering from any apparent illness. At 4.30 she called to her sister, and then it was found that she had swallowed a quantity of arsenic. There was then no sickness. After this, she was sick once, and purged once, but complained of no pain. She drank some tea, but almost immediately became collapsed, and seemed to those who were with her to be falling into a fainting fit. She died before six o'clock, and was sensible to the last. She could not have taken the poison more than two hours before she died. On inspection the day following, the whole mucous membrane of the stomach was intensely inflamed, presenting a dark scarlet colour, with broad livid patches. Upwards of an ounce of solid arsenic was found in a pasty state on the mucous membrane of the stomach, which was raised, thickened, and velvety. This case shows not only that there may be extensive morbid changes in the dead body within a short period after the taking of the poison, but that, with an unusually large dose, the symptoms of vomiting, purging, and pain may be slight and bear no proportion to the quantity of poison taken. Blood of a dark colour may be effused in various parts within the folds, or beneath the lining membrane—an appearance which has been mistaken for gangrene. A raised circular or oval patch of false membrane with an intensely red border, and with arsenic upon its surface, may be sometimes seen upon the inner coat. [See the case of the *Queen* against *Dore and Spry*, C. C. C. August 28, 1848; also 'Med. Gaz.,' Nov. 24, 1848.] The

stomach often contains a mucous liquid of a dark colour tinged with blood. The coats are sometimes thickened in patches, being raised up into a sort of fungus-like tumour, with arsenic imbedded in them: at other times they have been found thinned. The mucous membrane is rarely found ulcerated, and still more rarely gangrenous. Ulceration of the mucous membrane, as the result of the action of arsenic, has been found as early as ten hours after the poison had been taken. Perforation of the coats is so uncommon a result of arsenical poisoning, that there are but few instances on record. In a case examined by M. Chevallier, the stomach of a person who had died from the effects of arsenic was found perforated at the larger end. The aperture is described to have been of the size of a franc-piece, round, soft, and somewhat thickened in its margin. There was no redness or sign of erosion about it, nor was there any appearance of ulceration on the other parts of the mucous membrane. Externally the stomach was covered with false membranes, arising from inflammation of the peritoneum. ('Ann. d'Hyg.' 1852, 1, 448.) This case is so imperfectly reported that it is impossible to say whether the perforation was caused by arsenic, or whether it was the result of previous disease. The mucous glands of the stomach have been found enlarged; but this is by no means an unusual morbid appearance from any cause of local irritation, without reference to poisoning. Various appearances are said to have been met with in the lungs, heart, brain, liver, kidneys, and urinary organs; but they do not appear to be so characteristic of arsenical poisoning as to admit of medico-legal use in enabling a medical man to distinguish poisoning from disease. It is to the stomach and intestines that he must look for the basis of reliable evidence in regard to appearances after death. Dr. Wilks met with an ecchymosed condition of the lining membrane of the left ventricle of the heart in a case in which a man died in twelve hours from acute poisoning by arsenic. Dr. Greiner met with a fatty state of the liver and bloodlessness of the body in one case of acute poisoning with arsenic. (Horn's 'Vierteljahrsschrift,' 1866, 2, 345.)

In a few instances the mouth, throat, and gullet have been found inflamed, but in general there are no changes in these parts to attract particular attention. The mucous membrane of the *small intestines* may be inflamed throughout, but commonly the inflammatory redness is confined to the upper part or to the duodenum, especially to that portion which joins the stomach. Of the large intestines, the rectum appears to be the most prone to inflammation. The liver, spleen, and kidneys present no appearances which can be connected with the action of arsenic, although these, like the other soft organs, may become receptacles of the absorbed poison. It is worthy of observation in relation to the known antiseptic properties of arsenic, that the parts especially affected by the poison (the stomach and intestines) occasionally retain the well-marked characters of irritant poisoning for a long time after death. Absorbed arsenic does not, however, appear to prevent the decomposition of the soft organs in which it is deposited.

Death from external application.—Poisoning by the external application of arsenic is not very common. In February 1864 I was required to investigate a case of suspicious death which occurred near Halesworth in Suffolk. A girl, æt. 9, died rather suddenly, after an illness of about ten days. The mother had rubbed some white precipitate ointment mixed with arsenic on the head of the child, which was diseased. Her object, she stated, was to kill the vermin on the scalp. No symptoms of note were observed until about the fifth day after the application, when the child appeared ill and complained of thirst. On the eighth day she was very unwell; there had been cramp, with slight action on the bowels, but no vomiting. She became drowsy, and died on the tenth day. Mr. Haward examined the body, and forwarded to me the viscera

for chemical analysis, the case being very obscure. The lining membrane of the stomach and duodenum was inflamed: in the stomach the inflammation was well marked towards the greater end: these were the principal *post-mortem* appearances. Traces of arsenic were found in the mucous fluids of the stomach, in the coats of the stomach and intestines, and in four ounces of the liver, but arsenic in a *solid* form could nowhere be detected. A portion of the diseased hairy scalp was examined, and yielded arsenic as well as mercury (from white precipitate) in large proportion, the arsenic being estimated at from two to three grains. From the evidence given at the inquest there was no doubt that the mother's account was correct, and that her child had died from the ignorant application of arsenic externally to a diseased portion of the scalp.

The remarkable features of the case were these: no symptoms appeared until after the fourth day, and then only great thirst; there was slight purging with cramps on the eighth day, and death took place on the tenth, without any vomiting. Arsenic was found in the stomach and contents, and its presence there might have led to an erroneous inference of its having been criminally administered by the mouth. It was, however, merely in traces, and obviously enough the result of mucous elimination. The nature and mode of occurrence of the symptoms were also opposed to any other presumption. That absorbed arsenic may be thus transferred from the blood to the stomach and intestines, has been distinctly proved by the experiments of Dr. Pavy and myself. ('Guy's Hospital Reports,' 1860, 6, 397.)

Arsenic in Vapour.—It is not often that a case is heard of in which white arsenic has caused death by reason of its having been breathed or swallowed in the state of vapour. In April 1858, a case involving the effects of arsenical vapours was the subject of an inquest in London (see 'On Poisons,' 2nd edit. p. 234); but on that occasion there was an entire failure of proof that the arsenical vapour was the cause of death. I am indebted to Mr. Oxley, of Rotherham, for the account of a case which fell under his notice, which was the subject of a trial at the York Lent Assizes, 1864.

The prisoner placed some burning pyrites containing arsenic at the entrance of the door of a small room in which there were eight children, including an infant in a cradle. From the evidence, it appeared that all the children suffered from the fumes, which were chiefly those of sulphurous acid. A canary that was in a cage died from the effects. The children were speedily removed from the house and recovered, but the infant was left there for an hour. It suffered from vomiting, and when seen by Mr. Oxley about seventeen hours afterwards, the child was pulseless: it vomited incessantly, was much purged, and appeared to be in great pain. It died about twenty-four hours after exposure to the fumes. On inspection, the stomach and intestines were slightly inflamed. The brain and lungs were congested, and the lining membrane of the trachea was of a bright red colour. Dr. Allan detected arsenic in the contents of the stomach, in the lungs, in the coats of the stomach and the spleen. None was found in the liver. The pyrites contained arsenic, and gave off while burning arsenious acid in vapour and sulphurous acid. Some of the appearances were owing to sulphurous acid, but death was probably caused by arsenic. The prisoner was found guilty of manslaughter. A case is reported, in which it is stated that the members of a family were made ill by arsenical vapours escaping from the walls of a room and that one of them died. ('Pharm. Jour.' July 1870, p. 66.)

Quantity required to destroy life.—The smallest fatal dose hitherto recorded was observed in a case communicated by Dr. Castle, of Leeds, to the 'Provincial Journal' (June 28, 1848, p. 347). A woman took half an ounce of Fowler's solution (arsenite of potash) in unknown doses, during a period of

five days. She then died, and on examination the stomach and intestines were found inflamed. Death took place by syncope (mortal fainting), and there was an absence of vomiting and purging. The quantity of arsenic which here destroyed life could not have been more than *two grains*. In another case, two grains and a half of arsenic, contained in two ounces of fly-water, killed a robust healthy girl, aged 19, in thirty-six hours. (See 'Med. Gaz.' vol. 39, p. 116.) Hence under circumstances favourable to the operation of the poison, the fatal dose in an adult may be assigned at from *two to three grains*. The number of deaths reported to have occurred from arsenic in England and Wales in four years (1863–7) was eighty-three.

Period at which death takes place.—Large doses of arsenic commonly prove fatal in from eighteen hours to three days. The average time at which death takes place is twenty-four hours; but the poison may destroy life within a much shorter period. There are now many authentic cases reported, in which death has occurred in from three to six hours. In 1845 I met with a well-marked case of death from arsenic in five hours; and in another, which occurred in April 1849, death took place in two and a half hours. ('Guy's Hospital Reports,' Oct. 1850, p. 183. See also 'Ann. d'Hyg.' 1837, 1, 339.) Mr. Foster, of Huntingdon, met with the case of a child under three years of age, who died within *two hours* from the effects of arsenic. The quantity taken could not be determined. A case also fatal in two hours occurred to Mr. Clegg (p. 253). The most rapidly fatal case which I have met with was communicated to me by Mr. Thompson. It is that of a youth, æt. 17, who died in April 1860, from the effects of a large dose of arsenic, the symptoms from which he suffered being of a tetanic character. The poisoning was the result of an accident at Ramsey, in the Isle of Man. The medical evidence at the inquest was to the effect that not more than *twenty minutes* had elapsed between the time at which deceased sat down to eat his supper, containing the poison, and his death. In some instances death does not occur until long after the average period. In one case in which an adult swallowed about half an ounce, death did not take place for *fifty hours*, and it is remarkable that there was an entire absence of pain. ('Med. Gaz.' vol. 48, p. 446.) In the case of the *Duc de Praslin*, one large dose was taken, but death did not occur until the *sixth* day. ('Ann. d'Hyg.' 1847, 2, 367.) In October 1847, a man who had swallowed 220 grains of arsenic was admitted into Guy's Hospital. He died on the *seventh* day. It is obvious that a patient who recovers from the first effects of this poison may still die from exhaustion or other secondary causes many days or weeks after having taken it, even although the whole of the poison has been eliminated from the body. Thus in the case of *Dr. Alexander*, death took place on the *sixteenth* day; and although a large quantity had been taken, no arsenic was found in the body. ('Med. Times and Gazette,' April 18, 1857, p. 389.) In one instance in which arsenic was applied externally to the head, the person did not die until the *twentieth day*. The longest duration of a case of poisoning by arsenic is probably that reported by Belloc. A woman, æt. 56, employed a solution of arsenic in water to cure the itch, which had resisted the usual remedies. The skin became covered with an erysipelatous eruption, and the itch was cured, but she experienced severe suffering. Her health gradually failed, and she died after the lapse of *two years*, having suffered during the whole of this period from a general tremor of the limbs. ('Cours de Méd. Lég.' 121.)

Chemical analysis. Arsenic as a solid.—In the simple state, *white arsenic* may be identified by the following properties:—1. A small quantity of the powder, placed on platinum foil, is entirely volatilized at a moderate heat (370°) in a white vapour. Should there be any residue, it is impurity; sometimes plaster of Paris or chalk is found mixed with it. If a small portion of

the white powder is very slowly heated in a glass tube of narrow bore, it will be sublimed without melting, and form a ring of minute octahedral crystals, remarkable for their lustre and brilliancy. Under a microscope of good magnifying power (250 diameters), the appearance of these crystals is remarkably beautiful and characteristic: one not exceeding the 4,000th of an inch in diameter may be easily recognized by the aid of this instrument. They may be measured even to the 16,000th of an inch in diameter. (See illustrations, pp. 258, 259.) It will be observed in these experiments that white arsenic in vapour possesses no odour. 2. On boiling a small quantity of the powder in distilled water, it is not readily dissolved, but it partly floats in a sort of white film, while a part becomes aggregated in small lumps at the bottom of the vessel. It requires long boiling, in order that it should be dissolved and equally diffused through water. This property of arsenic has given rise to some important questions on criminal trials. The floating of arsenic takes place whether the water is hot or cold, and whether the water is added to the poison or the poison to the water. (See the case of *Reg.* v. *Smith*, Wells Lent Ass. 1869.) This property has attracted attention, and in one instance was the means of saving life. 3. When the powder is treated with a weak solution of sulphide of ammonium in a watch-glass, there is no change of colour, as there is with most metallic poisons: on heating the mixture, the white powder is dissolved; and on continuing the heat until the ammonia is expelled, a rich yellow or orange-red film is left (sulphide of arsenic), which is soluble in alkalies, and insoluble in hydrochloric acid. 4. Heated on platinum-wire in a smokeless flame, the powder imparts to it a pale blue colour, while it is volatilized in white fumes. 5. Another test suggested by Bettendorff is the chloride of tin mixed with fuming hydrochloric acid. The mixture is brought to the boiling point, and it should remain colourless. If the hydrochloric acid contains a trace of arsenic, the liquid will acquire a light brown colour. On adding a minute quantity of solid arsenious acid to it, it is dissolved and instantly decomposed, metallic arsenic being deposited in the form of a brown or brownish black precipitate. A salt of antimony is not thus affected.

Reduction-process.—When a small portion of the powder, *i. e.* from one-fourth to one-twentieth part of a grain, is heated with some reducing agent containing carbon, such as *soda flux* (obtained by incinerating acetate or tartrate of soda in a close vessel), in a glass tube about three inches long and from one-eighth to a quarter of an inch in diameter, it is decomposed: a ring of metallic arsenic of an iron-grey colour, is sublimed and deposited in a cool part of the tube. A mixture of one part of cyanide of potassium with three parts of dry (anhydrous) carbonate of soda forms an excellent flux for the reduction of arsenic. The materials and tube should be well dried. About two or three parts of either flux to one part of arsenic will be found sufficient. In the absence of these fluxes powdered ferrocyanide of potassium may be used in a similar proportion. After heating, a minute trace of arsenic remains in the flux, which cannot be expelled by heat. During the reduction, there is a perceptible odour, resembling that of garlic, which is possessed by metallic arsenic only, while passing from the state of vapour into arsenious acid. This *odour* was at one time looked upon as peculiar to arsenic, but no reliance is now placed on it as a matter of medical evidence—it is a mere accessory result. In this experiment of reduction, there are frequently two rings deposited in the tube (fig. 12):—the upper and larger ring has a brown colour, and appears to be a mixture of finely divided metallic arsenic and arsenious acid: the lower ring is small and consists of the pure metal. In order to determine the *weight of a sublimate*, the glass tube should be filed off closely on each side of the metallic ring, and weighed; the sublimate may then be driven off by heat, and the piece of glass again weighed:—the difference or loss represents the weight.

These sublimates are remarkably light, and require to be weighed in a delicate balance. By heating gently the tube containing the sublimate (reduced to powder) in another tube of larger diameter, the metallic arsenic, during

Fig. 11.

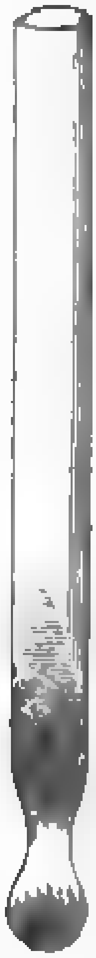


Fig. 12.

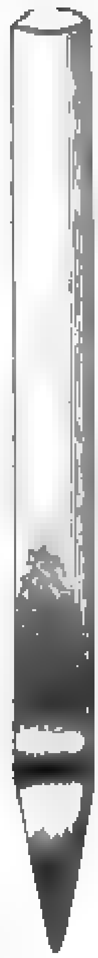


Fig. 13.

Fig. 14.

11. Berzelius's reduction-tube, with sublimate of metallic arsenic.

12. Ordinary reduction-tube, with two sublimates: the upper, brownish black; the lower, the pure metal in an annular deposit.

13. Small reduction-tube, with a crystalline sublimate of arsenious acid.

14. The tube with sublimate magnified, showing the octahedral form of the crystals. These are shown still more highly magnified in fig. 15, at p. 259.

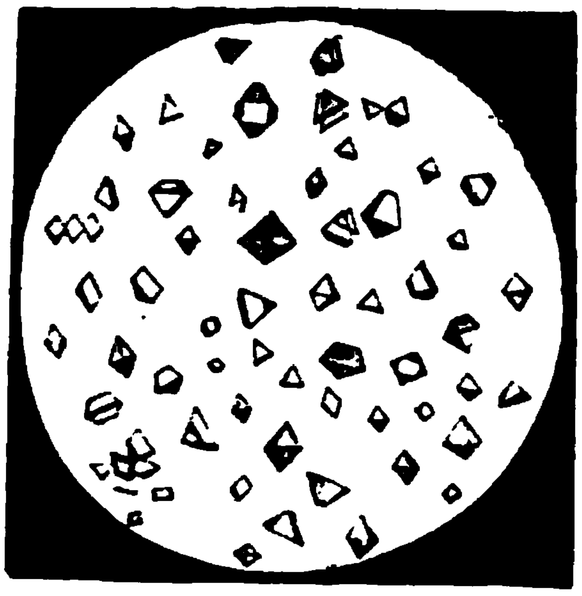
volatilization, forms octahedral crystals of arsenious acid, which, after examination by the microscope, may be dissolved in a few drops of water, and tested by one or more of the liquid reagents. The metallic sublimate, or the crystals produced from it, may be further subjected to the following process:—Break the glass on which the sublimate is deposited, into fragments, and digest these in a few drops of the strongest nitric acid, containing nitrous acid, previously proved to be free from arsenic. The sublimate is thereby converted into *arsenic acid*. The acid solution should be evaporated to dryness; the white uncrystalline residue obtained should be dissolved in a few drops of distilled water, and a strong solution of nitrate, or of ammonio-nitrate of silver added in small quantity to the residue. A brick-red colouration indicates arsenic acid, and thus proves incontestably that the sublimate was of an arsenical nature.

The upper or brownish-looking sublimate (fig. 12), may be readily converted into one of the pure metal, by gently heating it in the flame of a spirit lamp. Arsenious acid is then volatilized, and an iron-grey deposit of metallic arsenic appears. If the heat is continued, the whole of the metallic sublimate is volatilized and deposited in a cool part of the tube, in transparent and colourless octahedra of arsenious acid. This is the special character of an arsenical sublimate: it may be thus distinguished from sublimates of all metals or metalloids. The lower metallic sublimate procured by reduction (fig. 12) may appear not in an annular form, but in detached nucleated particles of a somewhat globular shape. These are of an iron-grey colour, quite unlike sublimed mercury, and when examined by the microscope, it may be seen that they consist of crystalline masses, that they are angular, and not strictly

spherical. This sublimate is sometimes produced in the last stage, when the residue in the tube is strongly heated.

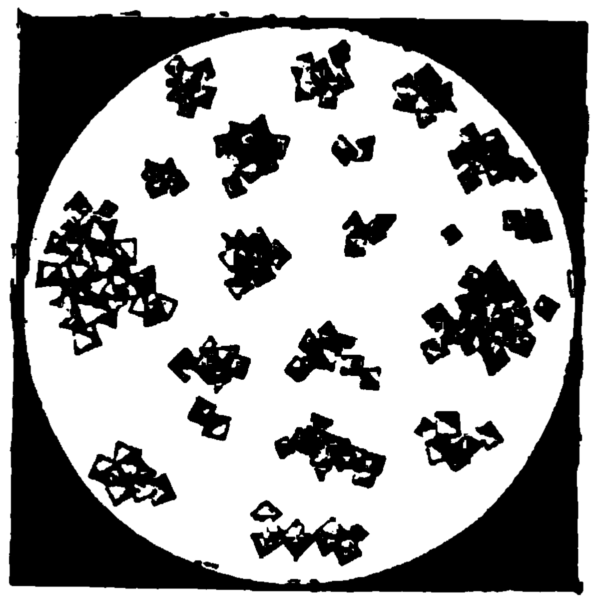
The *process of reduction*, with the corroborative results above mentioned, is, when thus applied, conclusive of the arsenical nature of the substance under examination.

Fig. 15.



Crystals of Arsenious Acid by sublimation, magnified 30 diameters.

Fig. 16.



Crystals of Arsenious Acid from a solution, magnified 124 diameters.

Arsenic in solution in water. Liquid tests.—The solution of arsenious acid is clear, colourless, possesses scarcely any perceptible taste, and has but a feebly acid reaction. In this state, we should first evaporate slowly a few drops on a glass-slide, when a crystalline residue will be obtained. On examining this with a microscope, it will be found to consist of numerous minute octahedral crystals, presenting triangular surfaces by reflected light. (See illustration, fig. 16.)

1. *Silver test.*—On adding to the solution *ammonio-nitrate of silver*, a pale yellow precipitate of arsenite of silver falls down;—changing, under exposure to daylight, to a greenish-brown colour. The test is made by adding to a strong solution of nitrate of silver, a weak solution of ammonia, and continuing to add the latter, until the brown oxide of silver, at first thrown down, is almost re-dissolved. The yellow precipitate is soluble in nitric, tartaric, citric, and acetic acids, as well as in ammonia. It is not dissolved by potash or soda.

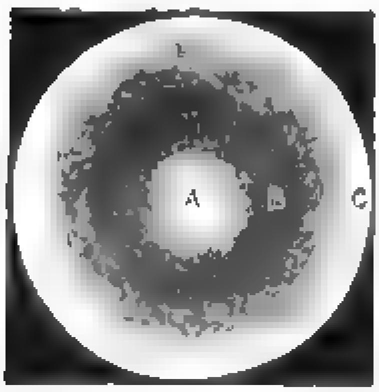
2. *Copper test.*—On adding to a solution of arsenic, *ammonio-sulphate of copper*, a light green precipitate (arsenite of copper) is formed, the tint of which varies according to the proportion of arsenic present, and the quantity of the test added: hence, if the arsenic is in small proportion, no green precipitate at first appears; the liquid simply acquires a blue colour from the test. In less than an hour, if arsenic is present, a bright green deposit is formed, which may be easily separated from the blue liquid by decantation. This test is made by adding ammonia to a weak solution of sulphate of copper, until the blueish-white precipitate, at first produced, is nearly re-dissolved: it should not be used in large quantity if concentrated, as the deep blue colour tends to obscure or conceal the green precipitate formed. The precipitated arsenite of copper is soluble in all acids, mineral and vegetable, and in ammonia, but not in potash or soda. If a small quantity of the blue ammoniacal solution of this precipitate is poured over a crystal of nitrate of silver, a film of yellow arsenite of silver will appear around the crystal, by the production of arsenite of silver. If a strong solution of nitrate is added to the blue liquid, nearly neutralized by diluted sulphuric acid, a yellow precipitate of arsenite of silver is also produced. Thus the silver and copper tests may be employed with one quantity of liquid. The *dried* precipitate of arsenite of copper, when slowly an-

moderately heated in a well-dried reduction-tube, yields a ring of octahedral crystals of arsenious acid—oxide of copper being left as a residue.

3. *Sulphuretted Hydrogen test.*—The sulphide of ammonium gives no precipitate in a solution of arsenic until an acid has been added, by which property arsenic is known from most metallic poisons. On adding an acid (dilute hydrochloric acid free from arsenic), a rich golden yellow-coloured precipitate is thrown down (orpiment or sulphide of arsenic). It is better, however, to employ, in medico-legal analysis, a current of washed sulphuretted hydrogen gas, which is easily procured by adding to sulphide of iron, in a proper apparatus, a mixture of one part of strong sulphuric acid and three parts of water. The arsenical liquid should be slightly acidulated with pure diluted hydrochloric acid, *before* the gas is passed into it: at least, care should be taken that it is not alkaline. The yellow compound is immediately produced if arsenic is present, and it may be collected after boiling the liquid sufficiently to drive off any surplus gas. The precipitation is likewise facilitated by adding to the liquid a solution of hydrochlorate of ammonia. The yellow precipitate is known to be sulphide of *arsenic* by the following properties:—1. It is insoluble in water, alcohol, and ether, as well as in diluted hydrochloric acid, and vegetable acids: but it is decomposed by strong nitric and nitro-hydrochloric acids. 2. It is immediately dissolved by potash, soda, or ammonia; forming, if no organic matter is present, a colourless solution. 3. When dried and heated with two or three parts of a mixture of carbonate of soda and cyanide of potassium (see p. 257), it gives a sublimate of metallic arsenic. Unless these properties are proved to be possessed by the yellow precipitate formed by sulphuretted hydrogen in an unknown liquid, it cannot be a compound of arsenic; and it would not be safe as a general rule to receive evidence on the point. On the other hand, when these properties are possessed by the precipitate, it must be arsenic and can be no other substance.

Marsh's process. Hydrogen test.—The action of this test depends on the decomposition of arsenious acid and its soluble compounds, by hydrogen evolved from the action of diluted sulphuric or hydrochloric acid on zinc. The materials should be first proved to be free from arsenic. The apparatus is of the most simple kind, and is so well known as to need no description. The arsenic may be introduced into the short leg of the tube in the state of powder; but it is far better to dissolve it in water, by boiling it either with or without the addition of a few drops of potash or hydrochloric acid. The metallic arsenic combines with the hydrogen, forming arsenuretted hydrogen gas, which possesses the following properties:—1. Filtering paper wetted with a solution of nitrate of silver is immediately blackened by the gas—the silver being reduced to the metallic state. Lead-paper is not changed in colour unless sulphuretted hydrogen is also present. 2. It burns with a pale bluish-white flame, and thick white smoke (arsenious acid). 3. A slip of glass or of white porcelain held in the flame near the point (for not too long a time) acquires a dark stain from the deposit of metallic arsenic upon it. This deposit presents a bright metallic lustre in the centre (A), a white film of arsenious acid on the outside (C), and between the two a dark ring of a pulverulent substance (B), which, when viewed by transmitted light, is hair-brown in colour towards the margin, but perfectly opaque in the centre. In order to determine the arsenical nature of the deposits, the following plan may be adopted:—Several of them should be received and accumulated in small porcelain cap-

Fig. 17.



Deposit obtained by Marsh's apparatus.
A. Metal.
B. Mixed deposit.
C. Arsenious acid.

sules, held over the burning gas. To one, add a solution of chloride of lime: the arsenical deposit is immediately dissolved. To a second, add a solution of sulphide of ammonium: the metallic deposit is detached, but not perfectly dissolved: yet on evaporation it yields a pale yellow film of sulphide of arsenic. To a third, add a few drops of the strongest nitric containing some nitrous acid. The deposit is dissolved: evaporate the acid solution gently to dryness: carefully neutralize the residue, and add one or two drops of a strong solution of nitrate of silver. A brick-red stain or a dark-red precipitate of arsenate of silver will be produced.

Reinsch's process.—In the application of this process, the liquid suspected to contain arsenic, or the solid dissolved in distilled water, is boiled with about one-sixth of its volume of *pure* hydrochloric acid (proved to be free from arsenic), and a small slip of copper is then introduced. A slip of polished copper foil (electric copper) about a quarter of an inch square, attached to the end of a fine platinum-wire, may be employed for the experiment. The copper must be first proved to be free from arsenic, as this is a very common contamination of commercial copper in the form of foil, gauze, or wire. Copper-gauze and wire generally contain arsenic. Pure electric copper free from arsenic can be procured in the form of thin sheet or foil. If arsenic is present in the liquid, even in small quantity, the polished copper acquires, either immediately or within a few minutes, an iron-grey metallic coating from the deposit of this metal. This is apt to scale off, if the arsenic is in large quantity, or if the liquid is very acid or long boiled. We remove the coated slip of copper, wash it in water, dry it, and gently heat it in a reduction-tube, when arsenious acid will be sublimed in minute octahedral crystals: if these should not be apparent from one piece of copper, several may be successively introduced. When the quantity of arsenic is very small, the polished copper merely acquires a faint violet or bluish tint. The deposit is in all cases materially affected by the quantity of water present, or, in other words, the degree of dilution, and sometimes it will appear only after the liquid has been much concentrated by evaporation. We are not obliged to dilute the liquid in the experiment, and there is no material loss of arsenic, as in the hydrogen process:—the whole may be removed and collected by the introduction of successive portions of pure copper. This process is extremely delicate, the results are speedily obtained, and are highly satisfactory. Among the cautions to be observed are these: 1, not to employ too large a surface of copper in the first instance; and, 2, not to remove the copper from the liquid too soon. When the arsenic is in minute quantity, and the liquid is much diluted, or not sufficiently acidulated, the deposit does not take place sometimes for half an hour. If the copper is kept in for an hour or longer, it may acquire a dingy tarnish from the action of the acid and air. There is one corroboration required. The steel-grey colour of the deposit is in itself characteristic of arsenic. It may be well seen with a low power of the microscope. The copper with the deposit upon it should be well dried, cut into small pieces if necessary, and introduced into a *dry* and perfectly clean reduction-tube. The application of a gentle heat by a spirit-lamp will cause the metallic arsenic to be volatilized as white arsenious acid, which is deposited in a cool part of the tube, in the form of octahedra or of the derivatives of the octahedron. When examined by a quarter of an inch power under the microscope, these crystals may be seen and recognized by their shape up to the sixteen-thousandth of an inch in width. The smaller the crystal the more perfect the form. (See fig. 14, p. 258.) If the copper with the deposit and the tube have not been well dried, the angularity of form is not distinct. These crystals may be tested by the processes already described.

The following is a simple method of detecting arsenic in copper. Add to

pure hydrochloric acid, diluted with six parts of water, one or two drops of a weak solution of persulphate or perchloride of iron. Boil the acid liquid and introduce the copper, well cleaned and polished, into the boiling liquid. Arsenicated copper acquires a dark tarnish, while the non-arsenicated (electric) copper retains its red colour under these circumstances. (Abel.) It will be found from this experiment that copper in the state of gauze or fine wire generally contains arsenic. This presents no obstacle to the detecting of arsenic by it, provided the copper gauze is not dissolved. Arsenic forms a solid metallic alloy with copper. It can only be separated by the destruction of the alloy and the solution of the two metals.

It is unnecessary in this place to enter into a comparison of the processes of Marsh and Reinsch, in respect to their relative powers of enabling the analyst to detect small quantities of arsenic. It may be conceded that Marsh's process will detect a smaller quantity of arsenic than the process of Reinsch, but the latter, when the quantity of liquid is small, will detect the 150th or the 200th part of a grain of the poison, and this is itself a point of delicacy in analysis which, when the issues of life and death are involved, might almost suffice to justify a reasonable distrust of the resources of science. It would require considerable courage to go beyond this, and it appears to me that in a criminal case it would not be safe to depose to the presence of arsenic from Marsh's process alone, when the quantity of poison was *too small* to admit of separation or corroboration by the process of Reinsch. Conversely the results of Reinsch's should be corroborated by those of Marsh's process. When the point of detection by Reinsch's process has been passed, then we increase the chance of fallacy to which Marsh's process is always exposed, by the fact that such very minute traces of arsenic may have existed in some of the materials used, or in the apparatus employed. It was this over-reliance on the extreme delicacy of the process in researches where it admitted of no corroboration whatever, that led Orfila to assert that arsenic was a natural constituent of the human body!

Arsenic in solids or liquids containing organic matter.—In testing *solids* generally for arsenic, we may employ the process of Reinsch. The solid is boiled in water acidulated with from one-fourth to one-sixth of its volume of pure hydrochloric acid, until it is either dissolved or its structure broken up. A small portion of pure copper polished is then introduced. In a few minutes, if arsenic is present—even to the extent of the thousandth part of a grain—there will be a metallic deposit on the copper, and this will yield crystals when heated in a tube. *Liquids* suspected to contain arsenic may be treated in a similar manner. Water is not required; the liquid is simply acidulated with one-fourth part of pure fuming hydrochloric acid. If the solution of the organic solid or the organic liquid is not deeply coloured, the chloride of tin, as suggested by Bettendorff, may be employed in place of the process of Reinsch. (See p. 257.) According to this authority less than the sixtieth part of a grain, even under considerable dilution, may be readily detected. It thus reveals traces of arsenic in sulphuric and hydrochloric acids.

The arsenic may be mixed with the organic liquid in the form of heavy lumps or powder. The great specific gravity of this substance allows of the liquid being poured off, and the sediment collected. When washed and dried, it will be found to be crystallized. It should be weighed, and then tested by the processes elsewhere described. Let us assume that the organic liquid is milk or beer, it will be necessary to determine whether any arsenic is dissolved in it. Filter a portion; place it in a dialysing tube (fig. 4, p. 215) and immerse the mouth of the tube in distilled water. In a few hours the arsenic will have traversed the animal membrane, and will be found in a clear and nearly colourless solution in the water. The fluid tests may be then applied to this liquid

for the detection of arsenic. They should never be applied directly to coloured organic liquids. All mucous, bloody, and farinaceous liquids containing arsenic, may be thus treated, and the arsenic speedily detected.

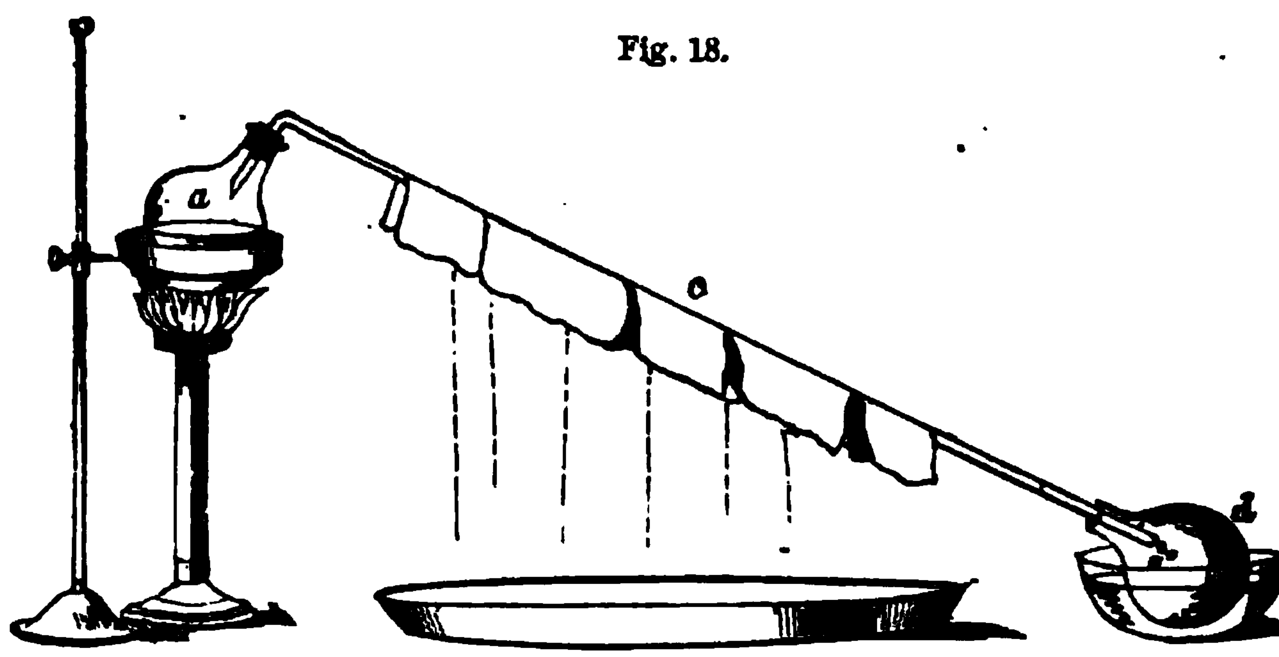
Precipitation as sulphide.—When arsenic is contained in an organic liquid in large quantity, it may be precipitated as sulphide by a current of washed sulphuretted hydrogen. The liquid should be boiled, filtered, and acidulated with pure hydrochloric acid before passing the gas into it. When precipitation has ceased, it should be again filtered, the precipitate collected, washed, dried, and weighed. By operating on a measured portion of the solution, the amount of white arsenic may be determined by the weight of the yellow sulphide obtained—five parts by weight of sulphide being equal to four parts of white arsenic. The properties of the yellow precipitate should be verified according to the rules mentioned at page 260. In some cases arsenic may be present, but in a quantity too small to be precipitated as sulphide by sulphuretted hydrogen. In others the presence of certain substances may interfere with or prevent precipitation. The presence of any alkali in a liquid prevents the formation of a precipitate. For this reason the sulphide of ammonium must not be used in place of sulphuretted hydrogen. It does not precipitate a solution of arsenic until an acid is added, and acids will precipitate from the test itself, sulphur which has been mistaken for sulphide of arsenic. An erroneous charge of poisoning has been based on this chemical mistake.

When arsenic is found in powder, as a sediment in organic liquids, it is obvious that it must have been taken in the solid state, and, although mixed with a liquid or solid, still in an undissolved form. Arsenic once administered in a state of solution, could not become again solid in the stomach except as a result of the perfect desiccation of the tissues. If found only dissolved, it may have been taken either in solution or in a solid form—the dissolved portion being part of the solid taken up by the fluids of the stomach, and the remainder having been expelled by vomiting and purging. This question was of importance in *Reg.* v. *Sturt*, Lewes Lent Assizes, 1863. The deceased, in this case, died from the effects of arsenic in powder, administered, it was believed, in a mince-pie. It was suggested that the poison might have been swallowed in ginger-beer, but then it could not have been in a state of solution: it must have been mechanically mixed with the liquid. The learned Judge who tried this case, was obviously not aware of any difference existing between the actual solution and the mechanical suspension of a solid in a liquid.

Distillation process.—When the poison is in so small a quantity that it does not admit of precipitation by sulphuretted hydrogen, and no solid particles of arsenic are found in the stomach, in its contents, or in any article of food, another method may be resorted to for detecting its presence. This method equally applies to the detection of arsenic deposited as a result of absorption in the soft organs of the body, as in the liver, kidney, or heart, and to arsenic in all its forms, except the pure insoluble sulphide or orpiment. Although, after long interment, white arsenic passes, more or less rapidly, into the state of yellow sulphide as a result of chemical changes during putrefaction, the conversion is generally only partial or superficial. I have never found it to be so complete as to prevent the detection of the poison by the distillation process. The only condition for success is, that the substance, whether food, blood, mucus, the liver, or other organ, should be first thoroughly dried either by exposure to a current of air or by a water-bath. The dried solid should then be broken into small portions and placed in a flask or retort of sufficient capacity, with a quantity of the strongest fuming hydrochloric acid to drench it completely. The freedom of this acid from arsenic, should be first carefully determined. The complete separation of arsenic from organic substances depends greatly on their perfect desiccation, and on the concentration of the acid

employed. After some hours' digestion the retort or flask (*a*, fig. 18) containing the mixture—which should be of such a size that the materials should not fill it to more than one-third or one-half of its capacity—should be fitted with a long condensing tube (*c*), and then gradually heated by a sand-bath until the acid liquid begins to pass over. A metallic head, formed of a cone of tin plate or copper-foil, should be placed over the retort or flask so as to concentrate the heat and prevent condensation in the upper part of the vessel. A small flask receiver (*d*) with a loosely-fitting cork may be employed to collect the product. This should contain a small quantity of distilled water, so as to fix and condense any vapours that may pass over. The receiver, as well as the condensing-tube, should be kept cool by wetting its surface with cold water diffused on a layer of bibulous paper placed over it. The perfect condensation of the distilled liquid is ensured by this arrangement. The distillation may be carried to dryness on a sand-bath, or nearly so; and it may be sometimes advisable, in order to ensure the separation of the whole of the arsenic as chloride, to add to the residue in the retort another portion of pure and concentrated hydrochloric acid, and again distil to dryness. I have, however, found that portions of dried liver and stomach gave up every trace of arsenic by one distillation, when a sufficient quantity of hydrochloric acid had been used, and the process slowly conducted by a regulated sand-bath heat.

Fig. 18.



Apparatus for distilling organic and mineral substances containing Arsenic.

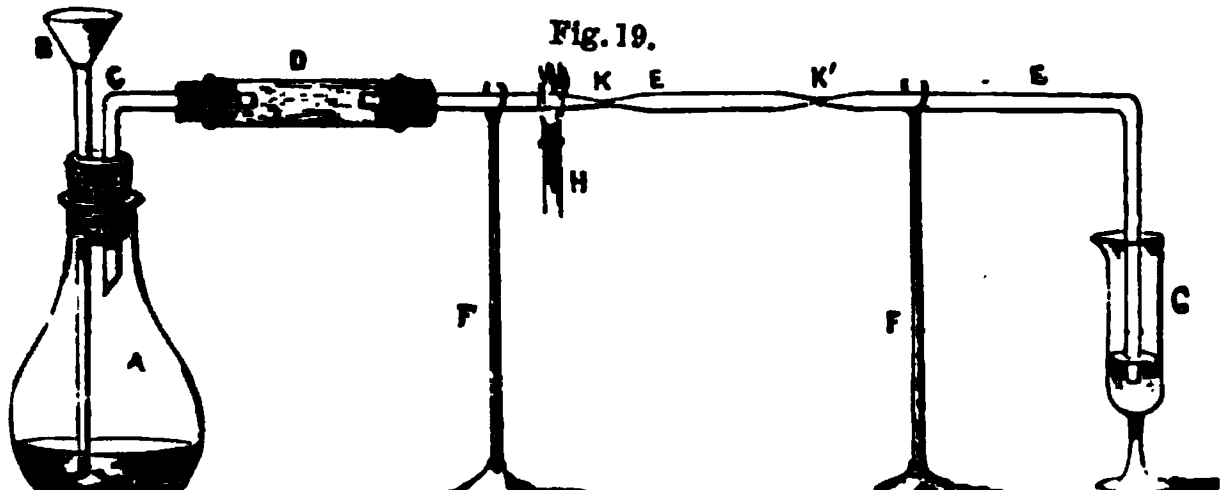
The liquid product may be coloured, turbid, and highly offensive if distilled from decomposed animal matter. Exposure to the air for a few hours sometimes removes the offensiveness, and there is a precipitation of sulphur, or of some sulphide, without any absolute loss of arsenic. The distillate may be separated from any deposit by filtration, and, if still turbid, it may be again distilled at a lower heat to separate it from any organic matter that may have come over.

If arsenic was present in the solid, the distillate will contain chloride of arsenic, which, although volatile, does not escape from a diluted solution at common temperatures. The quantity of dry organic substance used in the experiment must depend on the quantity of arsenic present, as revealed by a preliminary trial with Reinsch's process. If large, two or three drachms of the dried substance, or even less, will yield sufficient chloride of arsenic for further proceedings. For the absorbed and deposited poison, half an ounce of the dried organ, corresponding to two ounces of the soft organ, will frequently suffice; but a negative conclusion of the absence of arsenic should not be drawn from a smaller quantity than two to four ounces of the dried substance, whether liver, kidney, or heart. These tissues, it must be remembered, contain about 76 per cent. of water, so that the hydrochloric acid used will require less dilution. If oily matter should be distilled over, this may be separated by passing the distillate through a paper filter wetted with water.

I have found this process efficient for procuring a clear solution of chloride of arsenic from such different substances as starch—a cake—ordinary food—the liver and other soft organs—the scalp of the head—blood—contents of the stomach—arsenical wall-papers—metallic copper—blue vitriol—and various mineral powders. I have thus discovered arsenic in two ounces of the earth of a cemetery at Boston, and in a like quantity of earth from the cemetery of Kirkby Lonsdale, as well as in the mud of the Thames and the Mersey, in spite of the presence of much oxide of iron and earthy matter. Wherever the arsenic admits of solution in hydrochloric acid, however small the quantity present, it may be readily obtained as chloride. This distillation-process has the advantage of not interfering with the research for mercury, lead, copper, and other poisonous metals which do not form volatile chlorides. Arsenic is thus separated from them, and these metals may be found in the residue contained in the flask or retort. Even antimony, which forms a volatile chloride, is not so readily distilled over as arsenic. (On the diffusion of arsenic and the detection of this poison in the bones, see a paper by Dr. Sonnenschein, Horn's 'Vierteljahrsschrift,' 1870, p. 169.)

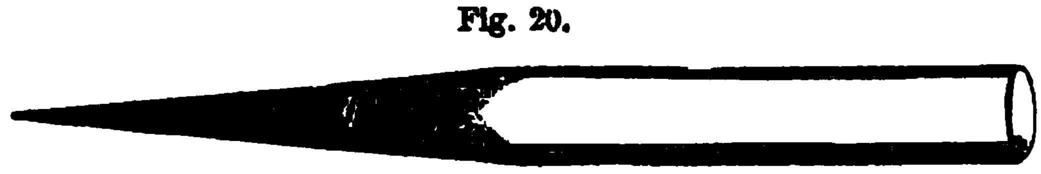
The distilled liquid may either be preserved for examination, or it may be at once submitted to a further stage of analysis. For this purpose one-third of it should be diluted with three or four parts of water and boiled in a clean flask. When boiling, a piece of bright copper-foil (free from arsenic), of about the size of the sixteenth of a square inch, should be introduced at the end of a platinum wire. If there is chloride of arsenic in the liquid, even up to the 1-4000th of a grain, its presence will be indicated by a change of colour, and

Fig. 19.



Apparatus for testing chloride of arsenic obtained by distillation.

Fig. 20.



Portion of tube separated with a deposit of metallic arsenic in the contracted portion.

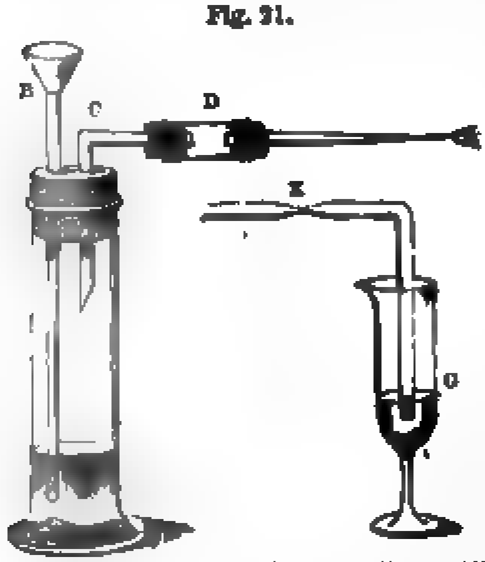
by the deposit of a dark metallic film on the copper. If the liquid should be too much diluted for this purpose, it may be concentrated on the polished copper, and the deposit will after a time be apparent. If the quantity of arsenic present is believed to be very small, the surface of copper introduced should be proportionately small. Bettendorff's process may be also employed for the detection of small quantities of arsenic in the distillate. Add to a solution of chloride of tin its bulk of fuming hydrochloric acid. Warm this mixture, and then add to it a few drops of the distillate. The presence and proportion of arsenic are indicated by a dark brown precipitate consisting of reduced arsenic. (For an account of this test see Wiggers' 'Jahresbericht,' 1871, p. 528.)

The remaining two-thirds of the distilled liquid, sufficiently diluted, should now be introduced into a Marsh's tube, or into an evolution flask provided with a funnel-tube, the capacity of which must be regulated by the quantity

of acid liquid to be examined. The kind of apparatus employed in this stage is represented in the engraving, fig. 19, p. 265. A, the flask, with funnel-tube B, and connecting-piece C; the funnel-tube should be long enough just to dip below the surface of the acid liquid. The short connecting-piece is bent at a right angle, and, like B, is carried through a closely-fitting cork in the neck of the flask. This tube should be only long enough to go through the cork, and its open end should be bevelled off to a fine point, so that any vapour which is condensed on it may fall back as liquid into the flask. D is the drying-tube containing fragments of chloride of calcium, secured by cotton at both ends. At the flask end of this tube should be placed some well-dried bibulous paper, saturated with acetate of lead and dried. This has the advantage of stopping any gaseous sulphur-compound, which may escape from the zinc or acid liquid. E E, a hard and not easily fusible glass tube, free from lead, contracted in two situations K K′, to about the diameter of the tenth of an inch or less, the tube itself having a diameter of from a quarter to three-eighths of an inch. F F are supports made of stout wire, to prevent the tube from falling when heated to redness. G is a test-glass to hold one or two drachms of a strong solution of nitrate of silver. H is a Bunsen's air-gas jet, which gives a stronger heat than a spirit-lamp, although the latter may be used.

The arrangement being thus made, the zinc and hydrochloric acid are first tested as to their freedom from arsenic. Portions of pure zinc are placed in the flask A, the parts of the apparatus are then connected, and pure hydrochloric acid, diluted with three or four parts of water, is poured into the flask by the funnel B, which operates as a safety-valve. Bubbles of air and gas speedily appear in the liquid in G, if the corks fit well, and the whole of the arrangements are air-tight. Pure zinc is sometimes but imperfectly acted on by the acid. In this case some clean platinum wire or foil may be wound round the bars of the zinc, and the evolution of hydrogen will be thus accelerated. It is, however, better that the hydrogen should come off rather slowly. If the materials are pure, the solution of nitrate of silver should undergo no change of colour. The glass G should be placed on a sheet of white paper, whereby the slightest tinge of brown or black is made perceptible. When all the air is expelled from the tube, the flame H may be applied to it at about one inch in front of a contraction of the glass, as indicated in the engraving, and the glass heated to redness.

Fig. 21.



Tube apparatus for testing a small quantity of liquid containing chloride of arsenic.

No metallic deposit should take place at K. If the materials are quite pure, the transparency of the glass tube at K will be unchanged. From a quarter to half an hour will be sufficient for this experiment. A portion or the whole of the distillate is now added to the acid liquid in the flask by means of the funnel-tube, taking care that it is never more than one-third full. The first indication of the presence of arsenic is manifested by the silver solution becoming gradually brown, and finally black, a dense precipitate of metallic silver resulting from the chemical changes. If it should become very suddenly black and flaky, the presence of sulphur may be suspected. This will be further indicated by a change of colour in the lead paper in D. Pure arsenuretted hydrogen does not alter the colour of this paper. When the silver solution is nearly blackened, the flame may be applied as indicated in the drawing, and kept steadily at this point. At a red heat, visible in daylight (1200°), arsenuretted hydrogen is decomposed, and metallic arsenic is

deposited; but being a volatile metal, it is carried onward by the hot current of gas, and forms at first a brown and then a black metallic mirror at K, *i.e.* in the contracted part of the tube which is cool. When a sufficiently thick deposit is obtained, the flame may be applied to the tube about an inch in front of K′. Thus as many deposits of metallic arsenic may be procured, as there are contractions in the glass tube.

The silver solution is allowed to become saturated with the gas. Any escape of the gas from the glass, or by leakage from any of the junctions of the apparatus, is at once indicated by holding near to the spot, filtering paper wetted with a solution of nitrate of silver. This is instantly blackened. The glass with the silver solution is then removed, the end of the tube well washed, or another tube substituted for E E, and this is allowed to dip into about one drachm of the strongest nitric acid, containing much nitrous acid in a test-glass similar to G, or into a small porcelain capsule. After a time, the acid loses its colour, and the metallic arsenic of the gas is converted into arsenic acid, which may be obtained by evaporation.

The further testing of the products is a very simple process. 1. The silver solution contains arsenic in the state of arsenious acid dissolved, with some nitric acid and the excess of nitrate of silver. By one or two filtrations it is obtained colourless and clear. A weak solution of ammonia is then added to it, and yellow arsenite of silver is at once precipitated (see p. 259). 2. The nitric acid liquid is evaporated to dryness in a small porcelain capsule. One or two drops of water are added to the residue, with a drop of weak ammonia if it should be very acid. A strong solution of nitrate of silver is then added to it: arsenate of silver, of its well-known brick-red colour, is immediately produced. 3. The portions of tube K K′ with the metallic deposits in them may be separated by a file, and then hermetically sealed, or, if necessary, one or more of them may be tested by the methods described in a preceding page (see p. 258).

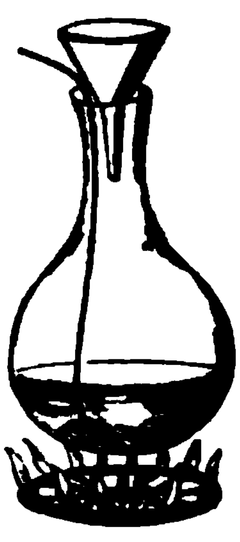
With these results the evidence of the presence of arsenic may be considered as conclusive. The poison is obtained by this process, not only in its pure metallic state, but in the distinct forms of its two well-known oxides—arsenious and arsenic acid. Any demonstration beyond this is superfluous. It will be observed that Reinsch's process is here employed merely as an adjunct to Marsh's process in an improved form in which the burning of the gas is unnecessary. The arsenic by distillation is first converted into chloride, the chloride into hydride, and the hydride into the respective oxides. In the different stages of this operation, all other metals, excepting antimony, are entirely excluded, and this, under the circumstances, may be easily distinguished from arsenic (see Antimony). The zinc which has been used for one experiment is not fitted for use in a second. M. Blondlot has discovered that in the usual method of operating on distilled zinc with hydrochloric or sulphuric acid, only moderately diluted, a blackish-brown flaky compound is formed which detaches itself from the zinc and floats in the acid liquid. He finds this to be arsenic in the form of a solid and insoluble hydride. Concentrated or diluted acids do not act upon it in the cold, but at a boiling temperature these acids decompose it. Nitric acid and chlorine rapidly dissolve it in the cold. Heated in a dry tube it is resolved into arsenious acid and water. Nascent hydrogen has no action upon it unless some organic matter is present, when it is instantly converted into arsenuretted hydrogen. It commonly attaches itself to the zinc employed in the experiment: by exposure to air it is gradually transformed into arsenious acid; and thus a bar of zinc which does not show the presence of arsenic on its withdrawal from the acid, may become coated with oxidized arsenic, as a result of exposure, so as to lead to a serious fallacy if used in another experiment.

Dr. Schneider of Vienna was the first to suggest, in 1851-2, a method of

extracting arsenic from organic matter as a volatile chloride. For this purpose he employed sulphuric acid and common salt. His process is well known on the Continent under the name of Schneider's process. It was described in the 5th edition of my 'Manual of Medical Jurisprudence,' 1854, p. 80. It has the disadvantage of introducing much mineral matter into the substance distilled—as well as of producing a large amount of froth, and thus embarrassing the operation. The modification of it above described, in which pure hydrochloric acid alone is required, will be found more convenient in practice.

Reinsch's process alone may be employed for detecting arsenic, deposited as a result of absorption, in the liver, kidneys, or other organs. About four ounces of the recent organ, or more, if necessary, cut into very thin slices, should be boiled in a flask in a mixture of one part of pure hydrochloric acid and two of water, until the structure of the organ is broken up. The flask may be of the shape represented in the annexed engraving (fig. 22), and either a naked spirit-flame or a sand-bath may be employed. A small glass funnel should be placed in the neck of the flask. This receives and condenses the vapour, which falls back into the flask. By this arrangement the boiling may be continued for a long time, without material loss by evaporation. The flask should not be more than half full, and heated gently until all froth is expelled. A slip of fine platinum-wire, having a small piece of pure copper-foil or gauze, should be immersed in the liquid when boiling. This enables the operator to remove the copper and examine it at intervals, after immersing it in distilled water. If it is much coated with a metallic deposit, larger portions of copper foil may be successively introduced until the liquid is exhausted. The deposits on the copper may then be tested by the methods described at page 261. This process is well adapted for the detection of arsenic in the urine and saliva eliminated from the living body, and in all liquid articles of food.

Fig. 22.



Flask employed in the analysis of substances by Reinsch's process.

It might be supposed that arsenic would escape as chloride in this method of operating, but when hydrochloric acid is diluted with this proportion of water, little or no volatile chloride is distilled over. In reference to the recent organs, a larger proportion of acid is used, because three-fourths of the weight of the animal substance really consist of water.

I have not here described the various carbonizing processes with sulphuric or hydrochloric acid and chlorate of potash which have been recommended for the purpose of destroying organic matter. If M. Blondlot's observations are correct, they have been the source of great and unsuspected errors in medico-legal analyses—sometimes withdrawing the poison altogether, and sometimes causing it to reappear under circumstances which are liable to create a fallacy. ('Annales d'Hygiène,' 1864, 1, 152.)

It is important, in reference to the presence of absorbed arsenic in the *tissues*, to observe that it may be found at an early period, when it is either absent or only doubtfully present in other parts. In a case referred to me in May 1854, the deceased, *Burton*, died within *four hours* after he had been attacked with symptoms of poisoning by arsenic. Arsenic was found in small quantity in the stomach, duodenum, and rectum. It was also detected in the liver and spleen; and the proportion found was greater in the latter than in the former organ. In November 1861 a man died from the effects of arsenic in the most acute form, soon after his admission into Guy's Hospital. He had swallowed unknowingly a large dose of the poison in water. His wife left him at 1.30 P.M. quite well: during her absence he swallowed the poison, and on her return at 4, she found him very ill and suffering from vomiting and

purging. He was brought to the hospital, and died soon afterwards. Barely *three hours* could have elapsed from the time at which the poison was taken until his death. There were the usual appearances in the stomach, intense inflammation, especially at the pyloric end; and gritty portions of arsenic mixed with masses of coagulated mucus, and false membrane, were found in the contents. The intestines were inflamed, and portions of arsenic were discovered as low as the cæcum. Arsenic was found abundantly in the stomach, and a comparatively large quantity of the poison was detected in half an ounce of the dried liver, as well as in the spleen and kidney. Hence it is obvious that the poison may be rapidly absorbed and copiously deposited within *three* hours, the quantity thus found depending apparently on the dose taken. In the cases of the *Atlee* family, referred to me by Mr. Carter, coroner for Surrey, in January 1854, the body of the mother was exhumed after a month. Arsenic was *not* found in the *stomach* or *bowels*, but it was readily detected in a small portion of the *liver*. The poison had probably been taken several days before death. The fact is of considerable importance in relation to a medical opinion of the presence or absence of poison in a dead body. It is commonly the practice to confine an analysis to the stomach and bowels only; and when no poison is found therein, to report that no poison exists in the body, and to refer death to natural causes. It is clear, however, from the above case, that such an opinion might be erroneous unless the liver or spleen had undergone a chemical examination. In preserving viscera for analysis, a portion of the liver should therefore always be set apart for examination. If the person has lived fifteen or sixteen days after having taken the poison, no trace may be found in the tissues or in any part of the body. Orfila long since expressed this opinion from his experiments on animals; its correctness has been strikingly confirmed by the case of *Dr. Alexander*, who died in *sixteen days* from a large dose of arsenic taken by mistake in arrowroot. The late Dr. Geoghegan, who was deputed to make an analysis of the stomach and other viscera, found no trace of the poison, either absorbed or unabsorbed, in any part of the body which he examined. (See 'Med. Times and Gazette,' April 18, 1857, p. 389.) It is the more necessary that the fact of entire elimination should be remembered, because it has been most incorrectly impressed on the public mind that no person can die from poison, except the poison be found by chemical analysis in the body after death. On some trials which have excited much public notice, men of repute as toxicologists have greatly added to the difficulties of medical evidence, and have embarrassed medical witnesses, by affirming that if death had really taken place from poison, it should always be found in the body. If this is untrue with respect to arsenic, it is necessarily untrue with regard to poisons less easy of detection in minute quantities.

In the case of the *Queen* v. *Williams* (South Wales Circuit, July 1863), the late Mr. Herapath, of Bristol, confirmed by his evidence the observations of Dr. Geoghegan. A woman was charged with the murder of her husband by administering to him arsenic. The evidence left no doubt that deceased had suffered from the usual symptoms of poisoning, namely, inflammation of the stomach and bowels, numbness of the limbs, and other symptoms. For some days before the deceased's death, owing to his food having been prepared for him by his daughter, the symptoms abated; but he ultimately died from exhaustion on the fifteenth day. Mr. Herapath examined the viscera, and found no arsenic. Neither in his reading nor in his experience had he known arsenic to have been detected fifteen days after its administration. As no poison was discovered in the body, the prisoner was acquitted on the charge of murder, but found guilty of the intent. ('Lancet,' July 11, 1863, p. 47.) In the case of *Soufflard*, a large dose of arsenic had been taken; but according to M. Legroux, no trace of the poison existed in the stomach or in the ulcerated portions of

the bowels. ('Union médicale,' June 30, 1850.) Dr. Otto met with a case of death from arsenic within twenty-four hours, with the usual symptoms and appearances, but no arsenic could be found in the contents of the stomach. The liver and other organs were not examined (Horn's 'Vierteljahrsschrift,' 1865, 1, 175.) When arsenic is discovered in the stomach mixed with food, it does not necessarily follow that it has been administered in that particular article of food. Should the person have partaken of liquid food such as milk or gruel, subsequently to the swallowing of arsenic, these fluids will necessarily acquire an arsenical impregnation from the poison already contained in the stomach. The patients may have taken the arsenic in one kind of food, when another and an innocent description of food might thus inadvertently be pronounced to have been the vehicle. (See on this point the case of *Ann Merritt*, 'London Med. Gaz.' Aug. 16, 1850, 46, 291.) Among the facts deserving of the notice of the analyst is this:—Arsenious acid reacts upon Trommer's test like grape sugar, and this substance might be wrongly pronounced to be present in place of arsenic.

It need hardly be observed that the *quantity of arsenic found in the stomach* or other organs can convey no accurate idea of the quantity actually taken by the deceased, since more or less of the poison may have been removed by violent vomiting and purging as well as by absorption and elimination. A large quantity found in the stomach or bowels indicates a large dose; but the finding of a small quantity does not prove that the dose actually taken was small. Notwithstanding these very obvious causes for the removal of a poison from the body, there is a strong prejudice among lawyers that the chemical evidence is defective unless the quantity found is sufficient to cause death. It would be just as reasonable, in a case in which a man has been killed by a discharge of small shot, to insist upon a failure of proof of the cause of death, because only a single pellet has been found in the body. The value of chemical evidence does not depend on the discovery of any particular *quantity* of poison in the stomach—it is merely necessary that the evidence of its presence should be clear, distinct, conclusive, and satisfactory. At the same time, a reasonable objection may be taken to a dogmatic reliance upon the alleged discovery in a dead body of minute fractional portions of a grain; and, considering the great liability to fallacy from the accidental presence of arsenic in the articles used, the chemical evidence in the French case of *Madame Laffarge* (1840), in which the whole quantity discovered in the dead body was stated to be the 130th part of a grain, was of a most unsatisfactory kind, and should have been rejected by the Court.

It has been supposed that the *quantity* of arsenic found in the stomach and bowels may throw a light on the question, whether the poison had been taken voluntarily with the intention of committing suicide, or whether it had been criminally administered by another; *i.e.* supposing the evidence to establish that there could have only been one act of administration. There is no doubt that a much larger dose may be taken by a suicide than could be secretly administered by a murderer; and thus, if a large quantity is found in the stomach, it is supposed to furnish a presumption in favour of suicide and against murder. Suicides have been known to take as much as two tablespoonfuls, or *one thousand grains*, of arsenic. In a case of suicide by arsenic, which occurred at the Bristol Infirmary in July 1872, a larger quantity had been taken. Dr. Smith found, on a post-mortem examination, four ounces of arsenic in the stomach, of which two and a half ounces were in one mass. The woman, when brought to the hospital, was in a state of complete collapse. Death took place rapidly. ('Pharm. Jour.' July 27, 1872, p. 75.) How much may remain in a dead body must depend on the amount of vomiting and purging, and the length of time the person survives. In one case of murder by poison I found in the stomach,

on the exhumation of the body, eighteen months after death, 20 grains of arsenic. In the case of *L'Angelier* (*Reg.* v. *Madeline Smith*, Ed. High Court of Justiciary, June and July, 1857), Dr. Penny stated in evidence that the quantity of arsenic which he found in the stomach and contents of the deceased amounted to 88 grains, and that some part of this was in hard, gritty, colourless, crystalline particles. As there was arsenic in the contents of the intestines, and there had been vomiting and purging, it is obvious that the deceased must have taken a very large dose of the poison; and it was one of the suggested difficulties of this case, to determine how the deceased could have taken the poison in so large a quantity unknowingly. The quantity found, however, amounted to no more than half a teaspoonful; and admitting that one half of the dose taken had been ejected, the question resolves itself into this: whether a teaspoonful of arsenic might not have been homicidally administered in chocolate, gruel, or some thick liquid, or in a state of admixture with solid food (cake). Although it is unusual to find half a teaspoonful of arsenic remaining in the stomach in a case of homicidal administration, it is impossible to admit that this fact is inconsistent with an act of murder. A man half intoxicated might be thus poisoned; and if death took place in a few hours, even a larger quantity than that which was here found might remain in the stomach. Sir R. Christison has now set this question at rest by the publication of a case in which a man was homicidally destroyed by arsenic, and the quantity found in the stomach after death was from 90 to 100 grains. The man had survived from five to seven hours, and there had been frequent vomiting of a yellowish or greenish coloured liquid during this period. The arsenic was administered in whisky-punch with sugar, and it was kept in suspension by constant stirring. ('Ed. Monthly Med. Journal,' December, 1857, p. 481.) In *Regina* v. *Dodds*, tried at the Lincoln Assizes in December 1860, the prisoner was charged with administering arsenic to deceased with intent to murder. The quantity stated to have been found in the stomach by the medical witnesses was 150 grains. There was no reason to suppose that he had taken the poison with suicidal intention; but, on the contrary, there was strong evidence to presume that it had been administered to him with a design to destroy life. I am indebted to Mr. Justice Willes for a note on a similar case. A woman named *Alice Hewitt* was tried before him (*Reg.* v. *Hewitt or Holt*) at the Chester Winter Assizes, 1863, and convicted of poisoning her mother with arsenic in the month of March preceding. Although the symptoms of irritant poisoning were very clearly marked, a medical man who attended her certified the cause of death as gastro-enteritis! Eleven weeks after the burial of the deceased, the body was exhumed and examined. It was proved that shortly before her mother's death, the prisoner had purchased a quarter of a pound of arsenic for threepence, and there was clear evidence of administration, a large dose having been given to the deceased in liquid shortly before her death. The inspection revealed the extraordinary fact that 154 grains of solid arsenic were found in the stomach alone. It had been partially converted into sulphide as a result of putrefactive changes, and it was observed that the liver, omentum, and right side of the heart were thickly painted with yellow sulphide of arsenic. In reference to this colouration, I have in one instance seen the front of the spinal column behind the stomach tinged of a deep yellow from arsenic which had escaped through the coats of this organ. If a person has died with arsenic in the body, there is scarcely any limit to the period at which it may be detected. In the cases of two children examined by the late Mr. Herapath, in July 1849, the poison was discovered in the remains of the dead bodies after eight years' interment; in another case by Dr. Glover after twelve years ('Lancet,' July 9, 1853, p. 41); and in a remarkable instance which occurred to Dr. Webster, of Boston, it was discovered in the

remains of a body, after fourteen years' burial in a tomb. It has been sought for, and not found, at much shorter periods after death when there was a very strong suspicion that the poison had been taken: but it is highly probable that in these cases there was little or no arsenic in the bodies at the time of death. The longer a person has survived after taking this poison, the less probable is it, *cæteris paribus*, that arsenic will be found in the remains. With respect to its detection in the stomach and bowels, if the vomiting and purging have been violent and the person has survived some days, none may be found. It is singular, however, to notice with what tenacity the mineral occasionally adheres to the mucous membrane in spite of vomiting and purging. In the case of the *Duc de Praslin*, who died in six days from a large dose of arsenic, some portion was still found in the intestines ('Ann. d'Hygiène,' 1847, p. 402); and in a case which was the subject of a criminal trial at the Leicester Autumn Assizes in 1860 (*Regina* v. *Holmes*), Mr. Lankester informed me that arsenic was detected in the intestines, although the deceased had survived the effects of a large dose for seven days, and had suffered from the usual symptoms. The preservative effects of arsenic on the solid organs of the body has been already noticed (p. 102.) Dr. L. Pénard has directed attention to a fact connected with the presence of arsenic in a dead body, not hitherto noticed by medical jurists. Under a suspicion of poisoning with arsenic, ten bodies were exhumed in the district of St. Colens, in 1869. Dr. Charbonnier, who was charged with this duty, found that arsenic was present in quantity in two of the bodies which had been well preserved. There was no offensive smell of putrefaction about them, but a remarkable alliaceous odour like that of phosphorus ('Ann. d'Hyg.,' 1872, Juillet, p. 186). This was attributed to the probable escape of arsenuretted hydrogen as the result of decomposition. On this point, I may observe that in several cases of exhumation, in which arsenic was discovered in the bodies, no odour of the kind was perceptible. Further, phosphuretted hydrogen has a similar odour, and this was discovered in remains in which no arsenic was found.

The condition of the arsenic found in a dead stomach should be especially noticed. A witness should be prepared to say whether it is in fine powder or coarse fragments; whether it is mixed with soot or indigo, or whether it is in the ordinary state of white arsenic. These points may be material as evidence in reference to proof of possession, of purchase, or administration. Arsenic is *not* a normal constituent of the body. Under no circumstances is it found in the tissues after death, except in cases in which it has been taken by or administered to the deceased.

ARSENITE OF POTASH. LIQUOR ARSENICALIS. (FOWLER'S SOLUTION.)—*Symptoms and Appearances.*—There is, so far as I know, only one case recorded in which this solution has destroyed life. A woman took half an ounce (= two grains of arsenic) in divided doses, during a period of five days, and died from the effects. There was no vomiting or purging, but after death the stomach and intestines were found inflamed. ('Provincial Journal,' June 28, 1848, p. 347.)

A mixture of arsenic, soft soap, and tar-water, is largely used in agricultural districts for killing the fly in sheep. This has caused death, under the usual symptoms of arsenical poisoning, in at least two instances. There is no doubt that a mixture of this kind is injurious to sheep unless very carefully used. In *Black* v. *Eliot* (Newcastle Assizes, Feb. 1859), damages were claimed for the loss of 850 sheep, said to have been poisoned by dipping them in an arsenical mixture of this description. The jury found a verdict for the plaintiff, with 1,400*l.* damages. In *Smith* v. *Barker* (Bury Summer Assizes, 1870), it was proved that a number of sheep were poisoned from a similar cause, but

as there was some contributory negligence on the part of the plaintiff, a verdict was returned for the defendants.

Analysis.—This solution has the odour of tincture of lavender, is of a reddish colour, and has an alkaline reaction. One fluid ounce of it contains four grains of arsenious acid. It gives at once a green precipitate (arsenite of copper) with the sulphate of copper, and a yellow precipitate with nitrate of silver. Acidulated with hydrochloric acid, and treated with a current of sulphuretted hydrogen gas, it yields a yellow sulphide; and when boiled with this acid and copper, a deposit is obtained which readily furnishes octahedral crystals of arsenious acid. When boiled with chloride of tin (see page 257), metallic arsenic is deposited as a brown precipitate.

The *Arsenite of Soda* is as poisonous as the arsenite of potash. In December 1857, three hundred and forty children belonging to an industrial school near London were poisoned by this compound. It had been incautiously used for cleansing a steam-boiler, and had thus become mixed with the hot water which was drawn for the breakfasts of the children. The dose of arsenic taken by each child I found to be about one grain. All recovered, although some suffered severely. (See 'On Poisons,' 2nd edit. p. 378.) In the winter of 1863, a man died under symptoms of acute poisoning by arsenic, owing to his having drunk beer out of a pot which had contained this *patent* cleansing liquid!

Fly-water is a name applied to solutions of various arsenical compounds in water. Mixtures of this kind are formed by dissolving one part of the arsenite of soda or potash and two parts of sugar in twenty parts of water. Paper soaked in this solution, and dried, is used for poisoning flies; and perhaps this is the safest form in which arsenic can be used for such a purpose. A case of poisoning by fly-water, in which two grains and a half of arsenious acid destroyed the life of an adult in thirty-six hours, will be found reported in the 'Medical Gazette' (vol. 39, p. 116). Fly-powder is a dark-coloured mixture of metallic arsenic and arsenious acid. The latter gives to it poisonous properties.

Arsenite of Copper. Scheele's Green. Emerald Green.—This is the only metallic arsenite which is met with in commerce and the arts, and it constitutes, wholly or in part, a great variety of green pigments, known as emerald green (aceto-arsenite of copper) employed for paper-hangings, mineral green, Brunswick, Schweinfurt, or Vienna green. It is thus found in the form of oil-paint, in cakes of water-colours, in wafers, adhesive envelopes, or spread over confectionery, and lastly and most abundantly, in various kinds of green decorative papers used for covering the walls of sitting and bedrooms.

Symptoms and effects.—Although the arsenite of copper is insoluble in water, it is sufficiently soluble in the acid mucous fluids of the stomach to be taken up by the absorbents, and carried as a poison into the blood. A boy, aged three years, swallowed a small capsule of Scheele's green, used by his father as a pigment. In half an hour he complained of violent colic: there was frequent vomiting, with purging, cold sweats, intense thirst, and retraction of the parietes of the abdomen. The mouth and throat were stained of a deep green colour. Hydrated sesquioxide of iron was given: in about an hour the vomiting ceased, and soon afterwards the thirst and pain in the abdomen abated. The next morning the child was well. In another case a child, a year old, ate several pieces of a cake of arsenite of copper used for colours. There was immediate vomiting of a liquid containing green-coloured particles of the arsenite, but there were no other urgent symptoms. White of egg with sugared water, was given to it. After a short time the child became pale and complained of pain in the abdomen: the pulse was frequent, the skin cold, and there was great depression. Copious purging followed, soon after which the child reco-

vered. (Galtier, vol. 1, p. 636.) In the cases of two children poisoned by confectionery coloured with this substance, the chief symptom was incessant vomiting of a light green-coloured liquid, resembling bile diluted with water. Mr. Bully, of Reading. who reports these cases ('Medical Times,' April 28, 1849, p. 507), describes the symptoms as severe, although the quantity of poison swallowed was small. Under the use of an emetic of ipecacuanha, the children recovered. Dr. Rose met with a case similar in its details. ('Lancet,' March 5, 1859, p. 237.) See also 'Guy's Hosp. Reports,' Oct. 1850, p. 218; 'Medical Gazette,' vol. 43, p. 304; 'Edinburgh Monthly Journal,' July 1851, p. 1; and 'Lancet,' March 5, 1859, p. 237.) In two cases which I examined in January 1853, a small quantity of a confectionery ornament, coloured with arsenite of copper, proved fatal to two children. The symptoms and appearances were those of poisoning by arsenious acid. The quantity taken could not have been above two or three grains. The children picked up the ornament in the street and shared it between them. The poison was spread over a layer of sugar!

In a case which was the subject of a criminal trial, this substance was proved to have caused the death of a gentleman by reason of its having been employed to give a rich green colour to some blanc-mange served at a public dinner:—the person who employed it considering that emerald or mineral green was nothing more than an extract of spinach! It led to death under the usual symptoms, and the parties were convicted of manslaughter and sentenced to imprisonment. (*Reg.* v. *Franklin and Randall*, Northampton Summer Assizes, 1848.) Most of the colours used for confectionery are of a poisonous nature; the pink colour given by cochineal or madder is the only one which can be regarded as innocent.

Among other uses of this noxious compound, we find it employed for imparting a bright green colour to the shelves of bakers' and greengrocers' shops. An incident which occurred to myself will show that food may thus acquire an arsenical impregnation. Several loaves of bread were supplied to me, having upon the undercrust a quantity of green-coloured pigment, which on analysis turned out to be arsenite of copper, containing about fifty per cent. of arsenic! On inquiry, I found that the baker had recently painted the shelves of his shop with this pigment, and the hot loaves placed upon them had taken off a portion of the arsenical paint. It is easy to conceive that an accident of this kind, if undetected, might lead to serious results, and perhaps to erroneous suspicions. ('Medical Times and Gazette,' April 1854, p. 326.)

Another form of poisoning by this substance which has attracted some attention, is where the green pigment exists in the state of vapour or fine dust, and comes in contact with the membrane of the lungs or with the skin. A young man, after having been engaged for nine days in printing with an arsenical green pigment, was seized with irritation and watery discharge from the nose, swelling of the lips and nostrils, and headache. The next day he experienced severe colic, and great muscular weakness: but these symptoms disappeared in about eight days. It is probable that in this case, the arsenite of copper had been taken into the body through the mucous membrane of the lungs in the state of fine powder. According to M. Bouchardat ('Annuaire de Thérapeutique,' 1846, p. 209), the workmen who handle the emerald-green in making wall-papers are subject to serious disorders of health. They sometimes suffer from eruptions of the skin—one of the local effects of poisoning by arsenic (see 'Assoc. Med. Journal,' 1856, Sept. 6, p. 757, and Sept. 20, p. 810), with œdema (watery swelling) of the face, and boils frequently forming in the scrotum. There is irritation with discharge of fluid from the mucous membrane of the nose, and abundant salivation. In the more advanced stage there are colicky pains, frequent vomiting, headache, and prostration of strength.

('Annales d'Hygiène,' 1847, 2, 56; a paper by Dr. Vernois, 1859, 2, pp. 107, 319; Casper's 'Vierteljahrsschrift,' 1859, 2, p. 8; and 'Journal de Chimie,' Juillet 1858, pp. 394, 397.)

Wall-papers covered with the loosely-adhering aceto-arsenite of copper are, from their cheapness as well as their brightness of colour, extensively used in dwellings. This pigment contains fifty-nine per cent. of arsenic, and from some of these papers in the unglazed state, the noxious material may be easily scraped or removed by friction. A square foot may yield from twenty-eight to seventy grains of the arsenical compound, and in rooms exposing five or six hundred square feet, arsenic is thus liable to be distributed in the state of a fine dust or powder through the air of a room. I have detected this poisonous dust on books, picture-frames, furniture, and projecting cornices in rooms thus papered. Workmen who hang these papers or who strip them off the walls, suffer from symptoms referable only to the action of arsenic. (See Husemann, 'Jahresbericht der Toxicologie,' 1871, p. 525, and 'Pharm. Jour.' 1870, p. 218; also 'Lancet,' 1870, vol. 2, p. 356.) One of my friends who had his library papered with an arsenicated wall-paper, suffered severely from symptoms of arsenical poisoning, which came on after he had been occupied in dusting his books. I examined the dust, and found therein a well-marked quantity of arsenic. M. Roussin has traced the means by which this insoluble poison finds its way through the skin, and the circumstances under which it may be absorbed by the unbroken skin. In two cases which proved fatal in 1865, the workmen suffered chiefly from vomiting and colicky pains. The skin was tinged of a green colour, and arsenic was detected in the soft organs. He found that all poisons were liable to be absorbed by the unbroken skin, when as a result of evaporation a solid film was left on the surface. Alcohol and other solvents of fat when used as solvents for the poisonous solid would favour its absorption into the body. It requires no theory of idiosyncrasy to account for poisoning under such circumstances. ('Annales d'Hygiène,' 1867, pp. 179, 182.) Dr. G. Kirchgässer, of Coblenz, has published an elaborate paper on this chronic form of poisoning, which he calls 'Arsenicism.' He has collected twenty-one cases of poisoning, as the result of persons inhabiting rooms the walls of which were covered with this green arsenical pigment. Some of these proved fatal. The poison appears to have entered the body in the form of a fine powder or dust. Arsenic was in many cases detected in the urine of the patients. (Horn's 'Vierteljahrsschrift,' 1868, 2, 96; also 'Annales d'Hygiène,' 1869, 1, 480.) It is probable that if sought for it would be found in the saliva; this might aid diagnosis. M. Delpech has published some facts which show that similar symptoms of poisoning have arisen from a person occupying a room filled with stuffed birds and animals, in the preservation of which an arsenical compound had been used. Arsenic was found in the dust of the room and on the furniture. ('Ann. d'Hyg.' 1870, 1, 314.)

The *symptoms* produced are of a uniform character, showing their origin from a common cause. They are as follows:—dryness and irritation of the throat with cough, irritation of the mucous membrane of the eyes and nostrils, dry cough, languor, headache, loss of appetite, nausea, colicky pains, numbness, cramp, irritability of the bowels, attended with mucous discharges, great prostration of strength, sleeplessness, a feverish condition, and wasting of the body. These symptoms may not all present themselves in any one case; they are derived from the examination of numerous cases which have been referred to me. No suspicion of the cause had been entertained until all ordinary treatment had failed to impart relief, and an analysis of the paper had been made. The connection of the symptoms with this cause appears to have been in some instances clearly established by the fact that after the removal of the paper, especially from bedrooms, the symptoms have disappeared. ('Med.

Times and Gaz.' 1871, 1, 674.) It is, however, proper to observe that, as in reference to the manufacture of white lead, comparatively few of those who are exposed, suffer from symptoms of poisoning.

Various deaths from the use of these arsenical papers are recorded; and it is probable that to the noxious practice of covering the walls of our sitting and bedrooms with arsenic, many insidious cases of illness and chronic disease may be referred. Mr. Orton published in the 'London Medical Review' some remarks on this form of poisoning, with cases demonstrating the danger and fatality arising from the use of the paper. The noxious arsenical compound is also much used for colouring artificial flowers, wreaths, and tarlatan dresses. Dressmakers occasionally suffer seriously from this form of poisoning. Two women were employed to make some green tarlatan into ball-dresses. They noticed an unpleasant smell and taste, and their eyes were affected during the performance of the work. The symptoms from which they suffered were swelling of the eyelids, congestion of the conjunctivæ and copious secretion of tears. The one most affected experienced on the second day salivation, with an unpleasant taste in the mouth, cramps in the limbs, great thirst, restlessness, and difficulty of breathing. These symptoms lasted in one patient eight and in the other fourteen days. Riedel, a chemist of Berlin, who describes these cases, suffered severely from a similar train of symptoms for several days, as a result of handling the poisoned dresses for the purpose of analysis. He found that the stuff contained thirteen per cent. of its weight of arsenic. (Husemann, 'Jahresbericht der Tox.' 1871, p. 525; also 'Jahresbericht,' 1872, p. 480.) I will add to this list the case of a lady (July 1872) who suffered severely from symptoms of arsenical poisoning, by reason of her having worn, on one occasion only, a dress of this description. Paper used for adhesive envelopes, for wrapping confectionery, children's food, isinglass, chocolate, &c., is also frequently coloured with it. Under proper sanitary legislation the manufacture and sale of this paper would be prohibited.

Analysis.—For the chemical characters of SCHEELE'S GREEN, see page 259. The wall-paper pigment called EMERALD GREEN is a mixture of arsenite and acetate of copper. The colour is most intense even by candle-light. The presence of arsenic in this compound may be easily detected by all the tests for arsenic (page 261); but the following is a simple method, which admits of speedy application. A slip of the suspected paper should be soaked in a moderately-strong solution of ammonia. The colour is removed, and the blue ammoniuret of copper is formed and dissolved in a few minutes. This result establishes only the presence of a compound of copper soluble in ammonia. If the ammonia does not become blue there is no arsenite present: if it does become blue, a crystal of nitrate of silver must be placed in a white saucer and a small portion of the blue liquid poured over it. The presence of arsenic is revealed by the production of yellow arsenite of silver over the surface of the crystal (page 259). Another method consists in adding a fragment of the paper to boiling chloride of tin, acidulated with fuming hydrochloric acid. Metallic arsenic is precipitated of a brown colour. A small portion of the paper dissolved in hydrochloric acid added to the apparatus represented in fig. 21, page 266, will set free arsenic in the form of arsenuretted hydrogen.

ARSENIC ACID. ALKALINE ARSENATES. Arsenic acid is an artificial product almost entirely confined to the chemical laboratory. Orfila states that it is a more powerful poison than arsenious acid, but he does not adduce any instance in support of this opinion. I have not been able to find any case of poisoning by it in the human subject. Dr. Glover ascertained that four grains of the acid, dissolved in two drachms of water, and introduced into the stomach of a rabbit, killed the animal in four hours with the symptoms of irritant

poisoning, and an affection of the nervous system. ('Ed. Med. and Surg. Jour.' vol. 58, p. 121.)

Analysis.—Arsenic acid is a white uncrystalline deliquescent solid. 1. It is not entirely volatilized when heated on platinum-foil in the flame of a lamp. 2. It is very soluble in water, forming a highly acid solution. 3. It is precipitated of a brick-red colour by nitrate or the ammonio-nitrate of silver. In these characters it differs from arsenious acid. 4. It yields readily an arsenical sublimate when heated with charcoal. 5. It yields deposits by Reinsch's process (page 261); but less readily than arsenious acid.

The arsenates of potash and soda must be regarded as active poisons, although there are but few instances on record in which life has been destroyed by them. Sir R. Christison states that, in the course of his reading, he has met with only two reported cases of poisoning by arsenate of potash. (Op. cit. 284.) The *tests* are the same as for arsenic acid. Arsenic acid and the arsenates yield a brown deposit of metallic arsenic when added to a boiling solution of chloride of tin (see page 257). A coarse sort of blotting-paper, soaked in a solution of arsenate of potash, is extensively sold for killing flies under the name of '*Papier Moure.*' It has been erroneously represented that the substance with which it is impregnated, is not poisonous to human beings. ('Lancet,' Feb. 11, 1860; also 'Ann. d'Hyg.' 1860, 1, 292.)

Arsenic acid is largely employed in the manufacture of magenta, rosaniline, and other colours from aniline. There is reason to believe that the colour is often sent into the market contaminated with arsenic. Dr. Rieckher has found from one to seven per cent. of arsenic acid in the red colours supplied by good manufacturers, and frequently arsenious acid was also present. ('Med. Times and Gaz.' 1870, 1, 617.) As these red compounds are used for giving a beautiful red colour to liqueurs, syrups, raspberry vinegar, and sugar sweetmeats, there is a possibility that accidents may occur from their use. They supplant all others by reason of their richness of tint and great cheapness. ('Med. Times and Gaz.' 1870, 1, pp. 46, 84.)

SULPHIDES, OR SULPHURETS OF ARSENIC. ORPIMENT.—Orpiment, or yellow arsenic, owes its poisonous properties to the presence of a variable proportion of arsenious acid, sometimes amounting to as much as thirty per cent. of its weight. Orpiment is much employed in the arts, in painting, dyeing, paper-staining, and even in the colouring of toys and sweetmeats for children, but is not often used as a poison! In December 1859 six persons suffered from the usual symptoms of poisoning by arsenic, owing to their having eaten *Bath buns.* It was found that a confectioner at Clifton had used, as he supposed, chromate of lead to give the buns a rich yellow colour, and make them saleable; but the druggist to whom he applied had ignorantly supplied him with orpiment. This wholesale system of poisoning is one of the attendant evils of adulterating articles of food. The *Bradford lozenge cases* (Nov. 1858) furnish a remarkable instance of the impunity attendant upon acts of this kind. A confectioner, intending to adulterate lozenges with plaster of Paris, mixed with them a quantity of white arsenic which had been supplied to him through mistake. I am informed that more than 200 persons partook of these poisoned lozenges, and suffered the usual effects. Seventeen persons died: twelve from acute poisoning, and five from the secondary effects. A trial took place, but the law could not fix the responsibility for the act upon any person.

Symptoms and Appearances.—Orpiment produces symptoms and appearances similar to those caused by arsenious acid; but the dose required to destroy life varies according to the proportion of arsenious acid with which it happens to be mixed. This is not a common form of poisoning; the yellow colour of the poison would lead to suspicion: but by reason of this colour, orpiment may be

given or taken, by mistake for mustard or turmeric. In a case which occurred to Dr. Jochner, two persons partook of some porridge, in which orpiment had been put, by mistake, for turmeric. They suffered from continual vomiting, burning pain in the stomach, and collapse. One, an old man, died in twenty-two hours; the other, a boy, recovered. On inspection, there was violent inflammation of the gullet and stomach, the mucous coat of the latter being softened and thickened. There was a sphacelated spot, one inch in diameter, in the gullet; and another in the stomach, three inches in extent. (Wharton and Stille, 'Med. Jur.' p. 434.) According to Dr. Chevers ('Med. Jur. for India,' p. 74), orpiment is much used in India both as a medicine and as a poison. He refers to eight instances in which this poison was found, either in food or in the stomachs of persons who had died under symptoms of irritant poisoning. Orpiment and realgar (another sulphide) are sold openly in India, and are used as depilatories. Orpiment has been known to cause death by *external* application as a depilatory (see 'Annales d'Hygiène,' 1834, 459).

Analysis.—The powdered sulphide yields a solution of arsenious acid on boiling it in water acidulated with hydrochloric acid. It readily gives the well-known sublimates of metallic arsenic, both with soda-flux and ferrocyanide of potassium (see page 260). *Organic mixtures.*—The sulphide being insoluble in water, it is in general easily separated mechanically, by allowing the matters mixed with it to become dry upon bibulous paper. If it cannot be separated mechanically, the organic matter suspected to contain it should be dried and boiled with the strongest nitric acid to dryness, until it is destroyed. Any sulphide will then be found under the form of arsenic acid, soluble in water (see page 276).

In *Reg.* v. *Sturt* (Lewes Lent Assizes, 1863), a novel question arose respecting this compound. There was some reason to believe that the deceased woman had died from the effects of arsenic administered in confectionery. White arsenic was found in the stomach, and a question was put by the learned judge, as well as by the counsel for the prisoner, whether the confectioner might not have used yellow arsenic by mistake in order to give a colour, and this yellow arsenic have been converted in the deceased's body in twenty-four hours into white. It need hardly be remarked that the yellow colour is an essential character of orpiment. White may be converted into yellow arsenic in the dead body, but yellow cannot be spontaneously changed into white arsenic.

Chloride of Arsenic.—This is a solution of arsenic in diluted hydrochloric acid. It was formerly used in pharmacy, but is now excluded. It contains one grain and a half of arsenious acid in one fluid ounce, which is equal to the small proportion of three-sixteenths of a grain to a fluid drachm. Mr. Phillips states that it is a highly poisonous preparation, and from a case which I saw in Guy's Hospital in May 1857, this statement is confirmed. A woman took, in three doses, thirty minims over a period of twenty-four hours. The quantity of arsenic thus taken was not more than the *tenth part* of a *grain*, and yet the symptoms which followed were of a severe kind, resembling those of chronic poisoning. These were constriction of the throat, pain and irritation of the stomach and bowels, tingling and numbness of the hands and feet, loss of muscular power, and a feeling of extreme depression. The medicine (a poison) was withdrawn, and the patient slowly recovered. It seems that she had not taken arsenic previously, and there was no evidence of the existence of a peculiar susceptibility to the effects of arsenic. The quantity taken was very small to produce such alarming effects. The usual medicinal dose of this solution was from three to ten minims.

Analysis.—This compound is obtained in the separation of arsenic from organic solids by distillation (see page 264). It may be tested by the process of Marsh or Reinsch, as there described. When boiled with fuming chloride

of tin, it is decomposed, and metallic arsenic of a brown-black colour is deposited.

Arsenuretted Hydrogen.—This is a gaseous poison of arsenic, producing, when respired in small quantity, very serious effects upon the system. It has already occasioned death in at least five instances. (See 'On Poisons;' 'Chemical News,' Dec. 26, 1863, p. 307; Husemann, 'Jahresbericht der Toxicologie,' 1871, p. 522.)

CHAPTER 21.

POISONING BY MERCURY—CORROSIVE SUBLIMATE—SYMPTOMS—CHRONIC POISONING —FATAL DOSE—APPEARANCES AFTER DEATH—PERIOD AT WHICH DEATH TAKES PLACE—CHEMICAL ANALYSIS—PROCESS FOR MERCURY IN ORGANIC LIQUIDS—WHITE AND RED PRECIPITATES—OTHER COMPOUNDS.

Metallic Mercury is not regarded as a poison. A large quantity of it in the fluid state may be swallowed without affecting health, or without causing more uneasiness than that which may arise from its great weight. It rapidly passes through the bowels. If the mercury is breathed or swallowed in a state of vapour, or if applied to the skin or mucous membrane in a state of extreme mechanical division, in which state it appears to be easily susceptible of oxidation, it is liable to be absorbed, and to produce a poisonous action on the body. The effects are principally manifested by salivation, by trembling and involuntary motions of the limbs, loss of appetite and emaciation. These symptoms are occasionally seen in workmen engaged in trades, in which they are exposed to the inhalation of mercurial vapours. Cases of mercurial poisoning are not so frequent as those of poisoning with arsenic. In England and Wales, in four years (1863–7), fifty-eight deaths from mercurial poison were recorded.

Blue pill and *Mercurial ointment* are preparations in which mercury is finely reduced, and probably, as in the mixture of mercury and chalk, more or less oxidized. A case in which a woman is reported to have died from taking excessive doses of blue pill is reported in the 'Medical Times and Gazette,' vol. 1, 1863, p. 446. Blue or mercurial ointment, which contains nearly half its weight of mercury, has attracted some attention lately by reason of its poisonous effects on cattle. It is employed for the purpose of dressing sheep in place of arsenic, and so much has been used in Lincolnshire, that Mr. Gamgee informs me twenty-five tons of this ointment had been sold in one year by a druggist in Boston, chiefly to farmers. In March 1863, I was consulted in reference to the death of many sheep belonging to a farmer near Stamford; it was supposed that the blue ointment employed was not pure, but that it contained corrosive sublimate or some other deadly poison. The sheep were quite healthy before the ointment was applied, as a dressing for the fly; but soon afterwards, they began to die at the rate of six per diem, until upwards of forty were lost. The chief symptoms preceding death were short breathing with a peculiar grunt indicative of pain, and the heads of the animals drooped to the ground. On inspection the lungs were generally found congested. On analysis the ointment was found quite pure. Mr. Gamgee informs me that he has been consulted in cases in which sheep have been poisoned by repeated dressings with blue ointment; and he affirms that ruminants are more easily killed by such an application than other animals. He found that sheep thus poisoned with mercury, had been sent for sale to the dead-meat markets in London, and that they had realized more money than

sound mutton sold in the county of Lincoln. I agree with him, that this practice of inunction with mercury should be suppressed: it is not only injurious to cattle, but is often an unsuspected source of noxious food to human beings.

Mercury with chalk is commonly regarded as an innocent medicinal compound of the metal; but if long kept and exposed to light a portion of the mercury passes to the highest state of oxidation, and thus produces a poisonous effect upon the system. This may account for the severe symptoms which have sometimes resulted from this preparation in medicinal doses. Drs. Duncan and Seely, who have investigated the changes, state that in one specimen which should have contained 37·5 parts of metallic mercury, 4·05 parts had become converted into the black oxide, and 22·25 parts into red oxide.

CORROSIVE SUBLIMATE.—This substance has received a variety of chemical names. It has been at various times called *Oxymuriate*, *Chloride*, *Bichloride*, and *Perchloride* of *Mercury*. To prevent any confusion from scientific chemical nomenclature, the old and popular name of *Corrosive Sublimate*, expressing the principal properties of the substance, is here retained. It is commonly seen under the form of heavy crystalline masses, or of a white crystalline powder. Its *taste* is powerfully austere and metallic, so that no poisonous quantity of it could be easily swallowed without the person becoming immediately aware of it. It is very *soluble* in water, hot or cold, and speedily sinks in it, in which properties it differs strikingly from arsenic. I have found by experiment that one hundred grains of a cold saturated solution hold dissolved, at a maximum, ten grains of corrosive sublimate; and it is stated by most chemists that two parts of boiling water (212°) will dissolve one part of the poison. It is also readily dissolved by alcohol and ether.

Symptoms.—The symptoms produced by corrosive sublimate generally come on immediately or within a few minutes after the poison has been swallowed. In the first place there is perceived a strong metallic taste in the mouth, often described as a coppery taste; and there is, during the act of swallowing, a sense of constriction almost amounting to suffocation, with burning heat in the throat, extending downwards to the stomach. In a few minutes violent pain is felt in the abdomen, especially in the region of the stomach, which is increased by pressure. Pain in the abdomen has been sometimes wholly absent. There is nausea, with frequent vomiting of long stringy masses of white mucus, mixed with blood; and this is followed by profuse purging. The countenance is sometimes swollen and flushed, in other cases it has been pale and anxious. The pulse is small, frequent, and irregular, and is scarcely perceptible when the symptoms become aggravated. The tongue is white and shrivelled—the skin cold and clammy, the respiration difficult; and death is commonly preceded by fainting, convulsions, or general insensibility. The external parts of the mouth, when examined, are swollen, and sometimes present an appearance as if the cavity had been washed with a solution of nitrate of silver: the lips are often swollen. Suppression of urine has also been frequently noticed among the symptoms. It existed in a well-marked case of poisoning by this substance, at Guy's Hospital:—the patient lived four days, but did not pass any urine during the whole of this time. ('Guy's Hospital Reports,' April 1844, p. 24.) This symptom was observed in a case reported by Dr. Wegeler (Casper's 'Wochenschrift,' Jan. 10, 1846, p. 30), in which a youth, æt. 17, swallowed three drachms of this poison, and died on the sixth day. During the last three days, no urine was secreted. The case was otherwise remarkable from the fact, that no pain was experienced on pressure of the abdomen, and that the pulse underwent no change until shortly before death. In another case, reported by the late Dr. Herapath, in which a scruple of corrosive sublimate in solution was swallowed, suppression of urine and sali-

vation came on on the third day, and the patient died on the ninth day. ('Lancet,' Dec. 13 and 27, 1845, pp. 650, 698.) In a case observed by Mr. Morris, the quantity of urine secreted was small, and it produced a scalding pain when voided. ('Prov. Med. Jour.' Nov. 18, 1843, p. 126.) In this instance there was no purging.

The *external* application of corrosive sublimate to tumours or ulcers may destroy life with all the usual symptoms of acute mercurial poisoning. At the Winchester Lent Assizes, 1859 (*Reg.* v. *Crook*), a quack was convicted of manslaughter by applying corrosive sublimate in powder to a cancerous tumour in the face of deceased. The man suffered from the usual symptoms. After death the bowels were found extensively inflamed and ulcerated. Mr. May, of Reading, detected corrosive sublimate in the diseased part. In September 1871, a girl, æt. 9, died from the effects of this poison, locally applied to the scalp for the treatment of ringworm. The liquid applied was alcohol containing eighty grains of corrosive sublimate to the ounce. She suffered from mercurial poisoning in a severe form, and died on the fifth day after the application. This case is instructive to medical men. (See 'Pharm. Jour.' Sept. 9, 1871, p. 216; 'Lancet,' 1871, 2, 473; and 'Med. Times and Gazette,' 1871, 2, 353). No theory of idiosyncrasy is required to account for death under such circumstances. In the first edition of my work on POISONS (1848), p. 394, fatal cases are related of poisoning by corrosive sublimate through the unbroken skin. Two brothers thus lost their lives, the one dying on the fifth and the other on the eleventh day. Those who deny the power of the unbroken skin to absorb corrosive sublimate and cause all the usual effects of acute mercurial poisoning, should make themselves and not their patients the subjects of experiment.

This poison differs from arsenic: 1, in having a well-marked taste; 2, in producing violent symptoms in a few minutes: and 3, in the fact that the evacuations are more frequently mixed with blood. The symptoms produced by corrosive sublimate, in the first instance, resemble those of cholera; if the individual should survive several days, they are more like those of dysentery —violent straining, and mucous discharges mixed with blood, being very frequently observed.

Slow or chronic poisoning.—The symptoms are much modified when the poison is taken in small doses at intervals for some days or weeks. There are colicky pains with nausea, vomiting, general uneasiness, and depression. The salivary glands become inflamed and painful; the tongue and gums are red and swollen, sometimes ulcerated, and there is fœtor of the breath. A deep blue line, like that observed in poisoning by lead, is sometimes found around the edges of the gums. The patient experiences difficulty of swallowing and breathing. The constitutional effects are indicated by looseness of the bowels, difficulty of breathing, spitting of blood, cough, general trembling or convulsive movements of the limbs and palsy, with slow fever and emaciation, under which the patient sinks. One of the most marked effects of slow or chronic poisoning by mercurial preparations is *salivation*, or ptyalism, indicated by an increased flow of saliva. This is by no means a necessary symptom in cases of acute poisoning by corrosive sublimate, but it not unfrequently shows itself about the second or third day. In some instances the patient dies too rapidly for this effect to follow; but even when he survives some days, salivation is not always observed. In placing reliance upon this symptom, it must be remembered that salivation may arise from a variety of causes irrespective of the use of mercury. As mercury may be easily detected in the saliva by a process described below, the discovery of the metal in this fluid will show the real cause of the salivation (see page 287).

Appearances after death.—These, as in the case of arsenic, are chiefly con-

fined to the stomach and bowels. Corrosive sublimate, however, affects both the mouth and throat; the mucous membrane is softened, of a white or bluish grey colour, and sometimes inflamed; that which lines the gullet is similarly affected, and partly corroded and softened. The mucous membrane of the stomach is more or less inflamed, sometimes in patches; and there are masses of black extravasated blood found beneath it. Occasionally it has a slate-grey colour, and the mucous coat beneath may be found reddened. A case occurred in Guy's Hospital, in which the mucous membrane was simply inflamed: it much resembled the condition presented in cases of arsenical poisoning. The coats of the stomach are sometimes corroded, and so much softened that they cannot be removed from the body without laceration. Similar appearances have been met with in the small and large intestines, especially in the cæcum. In a case reported by the late Dr. Herapath, in which a scruple was taken, and death occurred on the ninth day, the mucous membrane of the stomach was softened, but there were no well-marked appearances of the action of the poison on this organ. The cæcum had been the seat of the most violent inflammation, the whole surface being of a deep black-red colour, and there were patches of sloughing in the coats. ('Lancet,' Dec. 27, 1845, p. 700.) In a case which occurred to Dr. Thomson, of Perth, in which a man died forty hours after having swallowed two drachms of corrosive sublimate in powder, the mucous membrane of the stomach, duodenum, upper portion of the ileum, and parts of the large intestines, were found of a bright red colour. This appearance was most marked at the cæcum and sigmoid flexure of the colon. The local action of the poison on the mouth and throat was in this instance considerable. ('Edinburgh Monthly Journal,' Dec. 1851, p. 532.) Perforation of the stomach is rare as an effect of this poison: there is, I believe, only one case on record. Appearances like those just described have been seen in the alimentary canal, not only where the case has terminated fatally in a few hours, but where it has been protracted for six, eight, and even eleven days. (Chaussier, 'Recueil des Mémoires,' p. 363.) In the case of a man, æt. 42, who swallowed, by mistake, thirty grains of the poison dissolved, and who died on the twelfth day, the stomach was found empty, the mucous membrane was of a dull, dark-red colour, chiefly about the smaller curvature. It was softened, and near the intestinal end was grey, pulpy, and gangrenous. In the gullet, the lining membrane appeared to have been stripped off in shreds. The intestines were in a state of intense inflammation, passing into gangrene. The other viscera presented no particular appearance. In this case the symptoms were manifested in a few minutes: there was a burning pain down the gullet to the stomach, described as if the parts were on fire; there was no mark of corrosion in the mouth; there was a sensation as if the throat were 'grown up:' and there was blood in the vomited matters as well as in the evacuations. There was no salivation at any period. ('Med. Times and Gaz.' Feb. 26, 1859, p. 210.)

Quantity required to destroy life.—The *smallest* dose which is reported to have destroyed life is *three* grains. This was in the case of a child; the quantity was accurately determined from the fact of its having been made up by mistake for three grains of calomel, which a physician had intended to prescribe. (This case is referred to in the 'Lancet,' 1845, p. 297.) It is probable that, under favourable circumstances, from three to five grains, or even less, would destroy an adult. Persons who had taken large doses have been known to recover when remedies were timely administered, or early vomiting was produced ('Med. Times and Gaz.' Feb. 18, 1860, p. 162); and sometimes recovery has been wrongly attributed to the remedy. In May 1862 a man swallowed eighty grains of corrosive sublimate dissolved in whisky and water. In ten minutes violent vomiting occurred. A mixture of albumen and milk was first given, and in about twenty-five minutes, gold-leaf with reduced iron made into a bolus

Some warm water had been previously administered in order to clear the stomach of any albumen or mucus. Vomiting recurred with less violence, the matters being mixed with gold-leaf. On the next day, there was no salivation, but in about eight days the man perfectly recovered. ('Ann. Jour. Med. Sci.' April 1863, p. 340.) Dr. Johnston attributed the recovery to the gold and iron, but there is not the slightest evidence that the metals had exerted any galvanic action in decomposing the corrosive sublimate: on the contrary, the particles of gold-leaf rejected after the administration of the antidote were apparently unchanged. The recovery was, no doubt, due to the early vomiting, and the free use of albumen and milk.

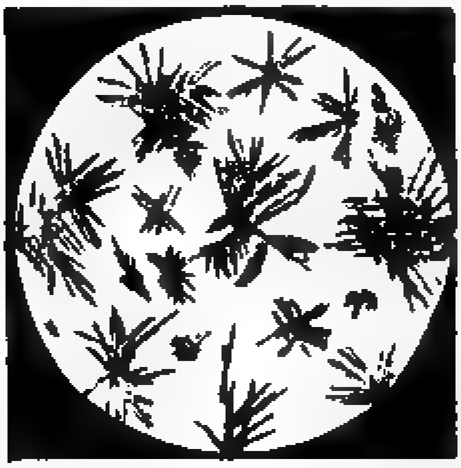
Period at which death takes place.—In an acute case, a person commonly dies in from one to five days; but death may take place much sooner or later than this. The shortest fatal case on record was communicated to me by Mr. Welch. The quantity of poison taken was not ascertained, but the man died in less than *half an hour*. ('ON POISONS,' CORROSIVE SUBLIMATE.) In a case reported in the 'Edinburgh Monthly Journal,' vol. 1, 1860, p. 958, an adult who took from 60 to 80 grains of corrosive sublimate, did not die until the *twelfth day*. The case was somewhat peculiar. On the first day there was no complaint of pain in the gullet or stomach; the throat was painful on the second day, and the mouth and gums were affected on the third day. On the eighth day the man had apparently recovered, but he gradually became weaker, and died on the twelfth day. In a case which occurred in September 1861, reported by Dr. Skegg ('Lancet,' Feb. 1, 1862), a large dose of corrosive sublimate (112 grains) caused death in three hours and a quarter. In another which occurred at Guy's Hospital in November 1861, about five grains of corrosive sublimate caused death in six days: in both cases the poison was taken dissolved.

In Dr. Skegg's case, a man, æt. 54, swallowed two pennyworth of the poison (a quarter of an ounce) at 11 A.M. When seen by Dr. Skegg, soon afterwards, he was on the bed in a state of great prostration: his skin was blanched, and covered with a cold clammy perspiration; he vomited a thick stringy albuminous-looking substance. There was intense pain over the abdomen, and great purging with discharge of blood: the pulse was scarcely perceptible, the membrane of the tongue and of the interior of the mouth was perfectly white from the local action of the poison. White of egg was given freely, and a mustard poultice applied to the abdomen. At one o'clock he was more depressed. At a quarter past two, Dr. Skegg again saw him, and found he had just expired. An inspection was made twenty-four hours after death. The external coat of the stomach was of a deep red colour. The mucous membrane internally had the appearance of a piece of dark crimson velvet, owing to the large quantity of blood extravasated. The intestines here and there were reddened. The great omentum for about an inch from the stomach was of a deep crimson hue. The other organs were healthy.

In the second case, in which only five grains of the poison, dissolved in vinegar, were swallowed by a man, æt. 25, the following symptoms were observed on his admission into Guy's Hospital. Immediately after swallowing it, he felt a burning heat in his throat, and vomited freely. In two hours, there was great pain in the abdomen, he passed blood in his evacuations, and brought up a thick yellow frothy matter, tinged with blood. There was suppression of urine. He died on the sixth day. On inspection, the gullet presented marks of the local action of the poison. The mucous membrane of the stomach was reddened, and throughout minutely injected. There was no appearance of chemical corrosion. The small intestines at their lower part, as well as the large intestines, were deeply injected. The cæcum was but slightly affected. Seven ounces of the liver, and one-half of the stomach, gave only

minute traces of mercury. The greater part of the poison had been discharged by vomiting or by elimination during the six days which the patient survived. Thus in spite of the removal of the poison from the stomach, the case may prove fatal. Dr. Eade reports a case in which a man swallowed a lump of corrosive sublimate: it was ejected from his stomach in about an hour. It was then smooth on the surface, and weighed about one drachm. The usual symptoms of mercurial poisoning followed, with suppression of urine. There was slight salivation on the fifth day, and the man died on the eighth day. Mercury was found in the liver. ('Lancet,' 1870, 1, 303.)

Fig. 23.



Stellated crystals obtained by heating corrosive sublimate, magnified 30 diameters.

Chemical Analysis.—Corrosive sublimate is usually seen as a *solid* in heavy crystals, or in the form of a crystalline white powder. 1. When the powder is heated on platinum-foil or mica, it melts, and is volatilized in a white vapour without leaving any residue. 2. When heated in a close tube, it melts and forms a sublimate, consisting of prismatic crystals in stellated groups. 3. The powder is changed in colour by the following reagents: iodide of potassium produces a bright scarlet, potash a yellow, and sulphide of ammonium a black precipitate; ammonia does not alter its colour. 4. The mercury and chlorine may be discovered by one process. Mix the powder with four parts of dried carbonate of soda (obtained by incinerating the bicarbonate), until the residue in the reduction-tube fuses and becomes white. A sublimate of metallic mercury in distinct and well-defined globules will be obtained. Detach, by a file, the end of the tube containing the fused residue, which is chloride of sodium with some undecomposed carbonate. Digest it in water with nitric acid, and apply heat until it is entirely dissolved: then add to the solution nitrate of silver. A white precipitate of *chloride* of silver, insoluble in nitric acid, will be at once produced. The solid is thus proved to contain both mercury and chlorine, and the only compound of these elements soluble in water

Fig. 24.

Prismatic crytals of corrosive sublimate from solution in water, magnified 30 diameters.

Fig. 25.

Crystals of corrosive sublimate from a solution in alcohol, magnified 30 diameters.

is corrosive sublimate. Corrosive sublimate is dissolved by water and alcohol. A few drops of the aqueous solution evaporated on a glass-slide yield slender opaque silky prisms (fig. 24). The crystals obtained from the alcoholic solution are larger and better defined (fig. 25). When a weak solution of iodide of potassium is dropped on them, they acquire a bright scarlet colour, and

chloride of potassium is formed. These characters, which may be obtained from the minutest crystal and only one drop of solution, prove that the body dissolved in water is corrosive sublimate: it is thus distinguished from every other mineral poison, and all other substances whatever. 1. Protochloride of tin added to a solution of corrosive sublimate, produces a black precipitate which, after it has been boiled, is resolved into globules of metallic mercury easily separable by filtration. The protochloride should be strong and mixed with its volume of strong hydrochloric acid. If while boiling the mercurial compound is added to it, there is an immediate precipitation of metallic mercury. The same result is obtained with all compounds of mercury excepting the sulphide. 2. Sulphuretted hydrogen and sulphide of ammonium produce, after a time, a black sulphide, not soluble in alkalies or diluted acids. 3. If the liquid is acidulated, and bright copper foil, wire, or gauze is plunged into it, the copper will acquire a silvery-white deposit, even in the cold, but more rapidly by heat. When the copper with the metallic deposit is heated in a tube, globules of mercury are obtained.

Fig. 26.

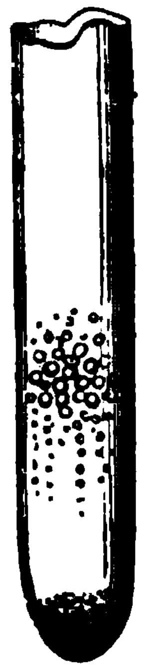
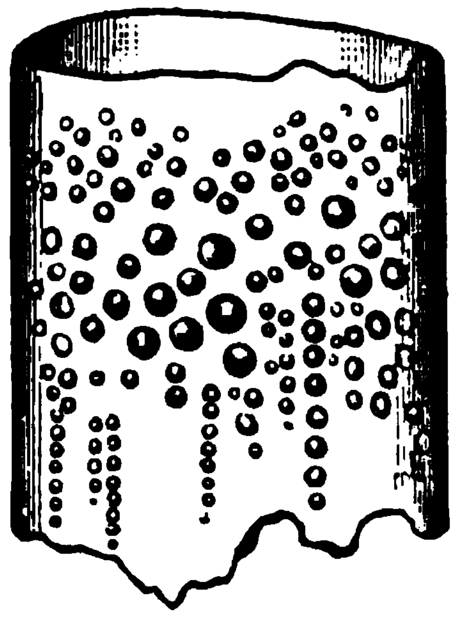


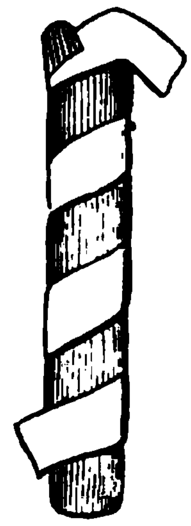
Fig. 27.



26. Mercury sublimed in globules, from corrosive sublimate, in a reduction-tube.
27. The same, magnified.

In Organic liquids.—The liquid should be separated by filtration from any insoluble portions. The latter should be pressed, dried, and set aside for a separate analysis. Any heavy mineral sediment may be obtained by decantation, dried, weighed, and separately examined. A slip of bright copper-foil or gauze may be employed as a trial test for the liquid portion. In place of copper, a small galvanic combination, made by twisting a layer of gold-foil round a layer of zinc-foil, may be introduced. The liquid should be slightly acidulated with hydrochloric acid and warmed. The metals should be suspended in the liquid for some hours. If the mercurial poison is present, even in small quantity, the gold will sooner or later lose its colour and become silvered, while the zinc will be wholly or in part dissolved. The slip of gold foil may be washed in water, and afterwards in ether and dried. It should be divided into two equal portions. One should be submitted to heat in a tube, when globules of mercury will be obtained; the other should be heated in a few drops of concentrated nitric acid, until the gold has reacquired its yellow colour. On evaporating the excess of acid, and adding a solution of protochloride of tin, a dark grey precipitate of metallic mercury is thrown down. It may be remarked that sublimed mercury is wholly unlike any other volatile substance. The perfect sphericity of the globules, their silvery whiteness by reflected, and complete opacity by transmitted light, at once identify them as metallic mercury. The sublimate of metallic mercury differs from that of arsenic in the fact that, when heated, it sublimes simply as a metal without change. It is not oxidized (like metallic arsenic), by heating it in a reduction-tube, but is simply transferred with its metallic lustre from one part of the tube to another. The mercurial sublimate is soluble in nitro-hydrochloric acid, yielding on evaporation white prismatic crystals of corrosive sublimate.

Fig. 28.



A layer of gold-foil round zinc-foil.

The yellow colour of the gold may not have been concealed by the mercurial deposit, owing perhaps to its great tenuity. Hence it is always proper to heat the gold in a reduction-tube before coming to the conclusion that mercury

is absent. The tube itself may not show a sublimate to the naked eye, owing to the minuteness of the globules, and their being much scattered. In all cases it should be examined, at first with a low, and subsequently with a high power of the microscope. Minute strings of globules, varying from the 1-8000th to the 1-16000th of an inch in diameter, may thus be detected. They are frequently deposited in a kind of chain in any minute crack or line on the interior of the glass tube. In the event of a doubt existing respecting the mercurial nature of the sublimate, the following experiment will remove it. Cut off by a file the portion of glass on which they are deposited: introduce this into a wide short tube, with a few drops of hydrochloric and half the quantity of nitric acid. Heat the acid liquid, and carry it to dryness on a sand-bath. White prismatic crystals of corrosive sublimate will remain, if the sublimate was of a mercurial nature, and too great a heat has not been applied. On touching the white residue cautiously with a drop of solution of iodide of potassium, the crystals will acquire a scarlet-red colour.

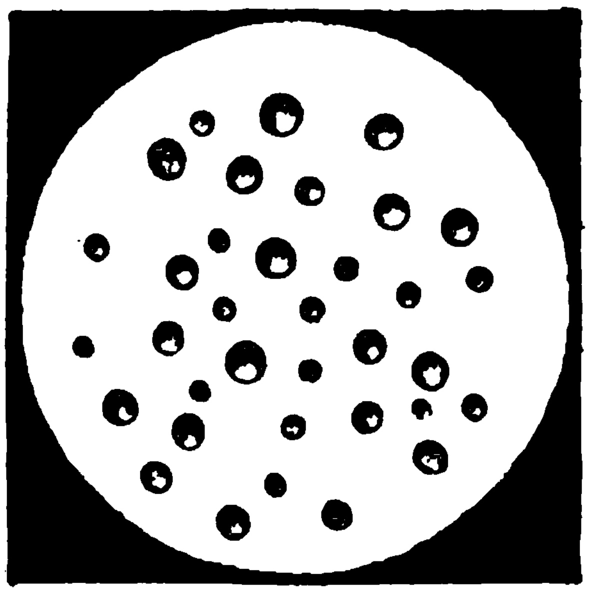
Another method of analysis may be sometimes usefully resorted to. Place the suspected organic liquid in a small golden capsule. Acidulate it slightly with hydrochloric acid, and touch the gold, through the acid liquid, with a slip of pure zinc foil. Mercury will be deposited in a white silvery stain on the gold, wherever the two metals have come into contact. Wash out the capsule with distilled water, and add a few drops of strong nitric acid. Pernitrate of mercury is thus obtained, which may be tested by the processes above described for the detection of the persalts of mercury. Any solid precipitates, or insoluble compounds of mercury, may be dissolved by strong nitric acid, and the solution tested for the metal. If none is found, the dried solid, mixed with dried carbonate of soda, may be heated in a tube, when mercury, if present, will be volatilized. Organic liquids containing any of the poison dissolved may be submitted to dialysis by the method already described under arsenic and other poisons.

Absorbed and eliminated mercury.—Although absorbed mercury, like other metals, is eliminated from the system, yet its elimination through the ordinary secretions appears to be slow, and subject to some uncertainty with respect to the time at which it occurs, as well as to the duration of the process. That it is rapidly absorbed and deposited in the tissues of the organs, is undoubted; but when once deposited, the period for its entire elimination can scarcely be predicted. Mercury in a man or animal, labouring under its immediate effects, cannot be so readily detected in the urine as arsenic. Mr. Tuson, of the Royal Veterinary College, informs me that he gave to a mare, at first four grains, and afterwards five grains, of corrosive sublimate twice a day. At the end of fourteen days, he tested a pint of urine for mercury, but he found none. After the lapse of three weeks, it was easily discovered in this fluid. The animal then left the infirmary. In a case of chronic poisoning by mercury, to be presently mentioned (see p. 292), mercury could not be detected in twelve ounces of urine which were voided while the patient was labouring under the effects of the absorbed poison, although several weeks had elapsed, and mercury was detected in the tissues after death.

In the search for mercury in living persons labouring under this poison, a large quantity of urine should be examined, and an analysis made at intervals. The urine should be evaporated to dryness, and the dry residue or extract treated by the following process, which is the same as that required for the *tissues*. From four to eight ounces of the liver or other organs should be dried, broken up, and then boiled until dissolved, in one part of pure hydrochloric acid and four parts of water. The acid liquid may be strained through linen, and the residue pressed. The liquid, if in large quantity, should now be concentrated by gentle evaporation, and while still slightly warm, a small piece

of copper-gauze (proved to be free from mercury) should be introduced, at the end of a fine platinum-wire, into the acid liquid. The copper may acquire a white, grey, or silvery tarnish in a few minutes or not until after twenty-four hours. It should be removed, washed in water and alcohol, and dried and examined by a low power of the microscope. The deposition of any white metal on the copper will then be perceptible. It may be rolled into a pellet and heated in a dry reduction-tube, when minute globules will appear as a sublimate. The sublimate in the tube should be examined with a microscope, and the copper should in all cases be heated, whether the red colour of this metal appears to be covered or not by any deposit.

Fig. 29.

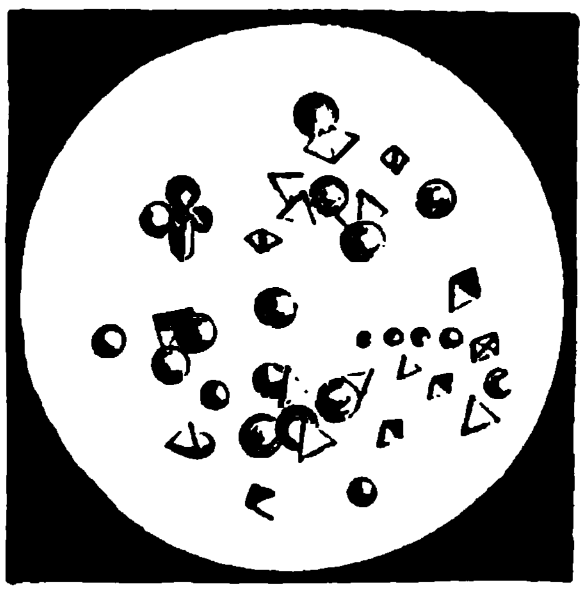


A small sublimate of mercury, magnified 124 diameters.

The efficiency of this method of detecting mercury when absorbed and deposited in the tissues, is indicated by the following fact. In an alleged case of poisoning (May 1864) a child died after an illness of twenty-two hours. Fourteen hours before death, two grains of calomel had been given to it. This had caused much purging, and mercury was found in one of the last evacuations passed. Four ounces of the liver were treated with hydrochloric acid and water, and a small piece of pure copper placed in the acid liquid while warm, and kept there for about forty-eight hours. It acquired a slight silvery lustre, and globules of mercury were obtained from it by sublimation.

If arsenic should be present in the tissues at the same time, and the acid mixture is boiled, arsenic and mercury will be deposited together; and when the copper is heated, the globules of mercury will be obtained nucleated or intermixed with octahedral crystals of arsenious acid. In a case of exhumation after twenty-one months' burial, these mixed sublimates were obtained by the examination of the rectum of the deceased. (*Reg.* v. *Bacon*, Lincoln Summer Assizes, 1857.) It appeared in evidence that arsenic had been administered to the woman a day or two before death, and a dose of calomel had been prescribed more recently. This accounted for the presence of the mixed sublimates.

Fig. 30.



Mixed sublimates of mercury and arsenious acid, magnified.

Arsenic is not readily deposited on copper in the cold, while mercury is readily deposited at all temperatures from acid liquids. We may sometimes take advantage of this difference in chemical properties, to obtain a separate deposit of this metal from a mixture.

In the living body mercury is eliminated by the saliva as well as by the urine. About one drachm of this fluid will suffice for the detection of mercury by the following process. Acidulate the saliva with one-fourth of its volume of pure hydrochloric acid. Immerse in this a portion of copper gauze, about the sixteenth of an inch square, attached to a fine platinum wire. Place the tube containing the liquid in a warm place for a few hours. If mercury is present in the saliva, the copper gauze will be whitened. Other portions may then be introduced until the mercury ceases to be deposited. The pieces of copper should be washed in water and ether, and dried,—examined by a low power of the microscope, and then heated in a small reduction-tube. Globules of mercury visible under the microscope will then be obtained. In

a case of inunction with mercury the metal was thus detected in the saliva on the third day. There was painful swelling of the salivary glands, with the peculiar metallic taste produced by mercury. This analysis of the saliva may not only furnish evidence that the patient is under the influence of mercurial poison, but it will prove, in a case otherwise doubtful, whether the *salivation* from which a person is suffering is owing to mercury or some other cause (p. 281). An examination of the saliva should be made in other cases of metallic poisoning, as arsenic, antimony, and other metals might be thus detected in the act of elimination from the living body.

The processes above described reveal only the presence of mercury. When the quantity of corrosive sublimate dissolved in an organic liquid is moderately large, it may be removed by means of ether. Place the filtered liquid supposed to contain the poison in a stoppered tube: add to it twice its volume of pure ether, and agitate the liquid at intervals for half an hour. Allow the liquid to subside, pour off the ether into a dial-glass, and submit it to spontaneous evaporation. As the ether passes off, the corrosive sublimate will be deposited in white silky-looking prisms. These may be purified by solution in water if necessary, and again crystallized. Corrosive sublimate may thus be separated from arsenic and other mineral poisons in solution. If mercury and arsenic are associated in a poisonous mixture, or in the tissues, the arsenic may be entirely separated by distillation (page 263). Masses of corrosive sublimate may be sometimes locked up in thick viscid mucus; and in such cases, the coarse powder being heavy, it may be separated by simply agitating the viscid liquid in water, and then decanting the upper portion suddenly. This poison is decomposed and precipitated by many organic principles, such as albumen, fibrin, casein, mucous membrane; also by gluten, tannic acid, and other vegetable substances. Thus, then, we cannot always expect to find it in the stomach, in a state of solution. Mercury is not a constituent of the human body. The discovery of it in the tissues, therefore, proves that it must have been received *ab extra*.

By one or other of the processes above mentioned we may be able to show the presence of *mercury*, but not of corrosive sublimate, in the body. Whether the mercurial compound had acted as a poison or not, must be determined from symptoms and appearances: whether it had been given or taken as a medicine or not, is a conclusion which must also be determined from other circumstances. The proof that the mercury was really in the form of corrosive sublimate, could only be derived from the discovery of some undissolved portions of the solid poison in the stomach or its contents, or from a separation of the poison itself by means of ether. If thus obtained after filtration of an organic liquid, it would show its presence in the form of a soluble salt: all the soluble salts of mercury are poisonous, and are rarely used internally as medicines. If undissolved, the absorbed mercury may have been derived from some mercurial medicine innocently taken by the deceased. Nothing is more common than to discover traces of mercury in the stomach, bowels, liver, kidneys, or other organs of a dead body. No importance can be attached to this discovery in the absence of evidence that the deceased has actually suffered from symptoms of mercurial poisoning. As to the mercury found in the tissues, it may have been derived from a soluble or insoluble medicinal compound, or from exposure to the vapours of the metal or of its salts in various trades.

A person may die from the effects of corrosive sublimate, and no mercury may be found in the tissues. A case of this kind occurred to me some years since at Guy's Hospital; and another, in which deceased died in fifteen days from a large dose of corrosive sublimate in whisky, has been reported by the late Dr. Geoghegan. On this occasion, although the local effects of the poison on the throat, stomach, and bowels, were of an intense kind, the viscera, on careful analysis, yielded no trace of mercury: the metal had been entirely eliminated in fifteen days. ('Med. Gaz.' vol. 46, p. 253.)

CALOMEL. *Subchloride of Mercury.*—This substance, although commonly regarded as a mild medicine, is capable of destroying life, in small doses, by causing excessive salivation with ulceration and gangrene, and in large doses by acting as an irritant poison.

Analysis.—It is known from corrosive sublimate by its insolubility in water, alcohol, and ether. It is known from white precipitate by its insolubility in acids, and by its being blackened by alkalies. A mercurial sublimate may be obtained from it by heating it with dry or anhydrous carbonate of soda.

WHITE PRECIPITATE. *Ammoniated Mercury.*—A few years since it was a contested question whether white precipitate was or was not a poison: and at the Chelmsford Lent Assizes in 1850, a woman who was indicted for administering this substance to her husband, owed her acquittal to the lenient assumption in her favour that it was *not* a poison. Out of fourteen cases which I have collected, in which white precipitate was taken in doses varying from a few grains to forty, two only proved fatal; and one of these was the subject of a trial for murder (*Reg.* v. *Moore*, Lewes Lent Assizes, 1860). The symptoms which it produces are violent vomiting, cramps, purging, and pain in the stomach, with convulsions. After death there is more or less inflammation of the stomach and bowels. In August 1863, a woman, æt. 30, swallowed a pennyworth of white precipitate and shortly afterwards a pennyworth of acetate of lead. In half an hour, there was violent vomiting with pain over the whole of the abdomen. An hour and a half afterwards the symptoms were, in addition to the abdominal pain, great thirst and a comatose condition. On the second day, there was slight tenderness of the gums, a flow of saliva, flushed face, with great tenderness of the abdomen; and on the fourth day profuse salivation. This subsided on the tenth day, and the woman recovered. ('Med. Times and Gazette,' 1863, 2, 645.) A young woman swallowed about thirty or forty grains of this substance by mistake for carbonate of soda. The chief symptoms were pain in the stomach and a spasmodic twitching of the muscles of the left arm and leg. These spasms continued for twenty-four hours. Emetics were given, and she recovered. ('Lancet,' 1871, 2, 540.)

A trial for attempting to poison by this compound took place at the Maidstone Summer Assizes, 1869 (*Reg.* v. *Seaham*). The compound is white, but as a result of boiling, it gave a yellow colour to the gruel in which it was administered. In *Reg.* v. *Hargreaves* (Manchester Lent Assizes, 1866), a girl was convicted of an attempt to poison her father by this substance. The poison was put into milk and medicine. It produced a burning sensation in the throat and stomach, and thus led to suspicion. About ten grains of white precipitate were detected in some buttermilk.

Dr. Pavy's experiments on dogs and rabbits show that this is a more formi-ble poison than it has been hitherto supposed to be. The greater number recoveries were probably owing to the substance being early ejected by miting. Rabbits, which do not vomit, were killed by a dose of four or five ains in a few hours. After death, mercury was found deposited in various gans, but more in the kidneys than in the other viscera. (For additional cts connected with the action of this poison, see 'Guy's Hosp. Reports,' Octo-r 1860, p. 483.)

Analysis.—White precipitate is a heavy insoluble chalky-looking compound ntaining about eighty per cent. of mercury. As it is sold in the shops, it fre-ently contains corrosive sublimate to the amount of one or two per cent. It ot used internally, but it is much employed by the poorer classes in the treat-nt of ringworm and other skin-diseases. It is soluble in acids, is not black-d by alkalies, and it yields a mercurial sublimate when heated with carbon- of soda. It is not dissolved by water, but becomes yellow by long boiling.

If boiled in a solution of potash, it evolves ammonia, and yellow oxide of mercury is precipitated. It may be detected in organic fluids and solids by boiling them in one part of hyrochloric acid and four parts of water. The mercury may then be separated by means of copper (p. 286).

RED PRECIPITATE. *Red Oxide of Mercury.*—This substance is poisonous, but instances of poisoning by it are rare. The following case occurred at Guy's Hospital in 1833. A woman, æt. 22, who had swallowed a quantity of red precipitate, was brought in labouring under the following symptoms: the surface was cold and clammy, there was stupor approaching to narcotism, frothy discharge from the mouth, and occasional vomiting: the vomited matters contained some red powder, which was proved to be red precipitate. There was considerable pain in the abdomen, increased by pressure; and there were cramps in the lower extremities. On the following day, the throat and mouth became painful, and she complained of a coppery taste. The treatment consisted in the use of the stomach-pump, and the free administration of albumen with gluten. She left the hospital four days afterwards, still under the influence of mercury. The quantity of oxide here taken was not ascertained.

Analysis.—Its red colour identifies it. When heated in a close tube, it is resolved into oxygen and mercury which is deposited in globules.

CINNABAR. VERMILION. *Persulphide of Mercury.*—The term *Cinnabar* is applied to a dark and heavy compound of sulphur and mercury, while *Vermilion* is the same substance reduced to a fine powder. It is well known as a red pigment, and is often employed in colouring confectionery and wafers. It is stated to have proved fatal to animals in the proportion of from thirty to seventy grains, when applied externally to a wound. Cinnabar is sometimes used for giving a red colour to ointments, *e.g.* the sulphur ointment: and it is also improperly employed by some dentists as a colouring matter to vulcanized rubber for mounting artificial teeth. Although this insoluble compound of mercury cannot be regarded as an active irritant poison in the stomach, the placing of it in such a situation that it should be always in contact with the mucous fluids of the mouth, is liable to lead to the usual consequences of chronic poisoning by mercury. In May 1864, a medical man consulted me under the following circumstances. Upon the recommendation of a dentist, he had worn this red composition as a frame for false teeth, in place of gold. After some time he perceived a metallic taste in his mouth, the gums became inflamed and ulcerated, there was great weakness and want of nervous power, with pains in the loins and an eruption on the legs. When the composition was removed, these symptoms abated. I examined the substance, and found in it a great quantity of vermilion: it had been mixed with the sulphur and rubber to give the appearance of the red colour of the gums. Dr. Wells, of Reading, has directed the attention of professional men to accidents of this nature. A patient of his, who had been provided with a frame of this description for the upper and lower jaws, perceived, soon after wearing it, a metallic taste in his mouth. His health failed, he lost his appetite, and became emaciated: he suffered from flatulency, fœtid breath, and looseness of the bowels: his pulse was 100 and weak, and his tongue coated with a white film. This gentleman was peculiarly sensitive to the action of mercury. He left off wearing the teeth, and became gradually better and stronger. ('British Med. Jour.' Sept. 5, 1863, p. 366.)

Dr. Sutro has published a short abstract of a case in which the *vapour of vermilion*, applied externally, produced severe symptoms. A woman, by the advice of a quack, applied this vapour to a cancerous breast. She employed three drachms of vermilion, and covered herself with a sheet, so that the vapour

should only reach the body externally. After three fumigations, she suffered from severe salivation and violent fever, which continued for four weeks. The right arm became œdematous. ('Med. Times,' Sept. 27, 1845, p. 17.)

Analysis.—Vermilion, or the organic compound containing it, may be entirely decomposed by nitro-hydrochloric acid. The residue, evaporated to dryness, contains corrosive sublimate. This may be taken up by water and the usual tests applied (p. 285). Ether will separate corrosive sublimate from the aqueous solution. The vermilion contained in vulcanite was thus readily analysed. The red sulphide of mercury is not blackened, like red lead, by sulphide of ammonium, and is not dissolved by hydrochloric acid, like red oxide of mercury. It yields an alkaline sulphide and globules of metallic mercury when heated with cyanide of potassium.

Cyanide of Mercury.—This is a substance which is but little known, except to chemists, yet it is an active poison, and has caused death in at least two instances. In April 1823, a person who had swallowed twenty grains of this compound (thirteen decigrammes) was immediately seized with all the symptoms of poisoning by corrosive sublimate, and died in nine days. There was continued vomiting, with excessive salivation, ulceration of the mouth and throat, suppression of urine, purging, and, lastly, convulsions of the extremities. On inspection, the mucous membrane of the stomach and intestinal canal was extensively inflamed. ('Orfila,' vol. 1, p. 735.) Sir R. Christison quotes a case in which ten grains destroyed life within the same period of time. (Op. cit. p. 427.) As a poison, the cyanide is not much inferior in activity to corrosive sublimate, but it has no corrosive properties.

Turpeth Mineral. *Subsulphate of Mercury.*—Fatal cases of poisoning by this compound are by no means common. Although insoluble in water, it is undoubtedly an irritant poison, and is capable of causing death in a comparatively small dose. A well-marked instance of its fatal operation was communicated to the Pathological Society by Mr. Ward, in March 1847. A boy, æt. 16, swallowed *one drachm* of this preparation on the night of February 19th. It produced a burning sensation in the mouth and throat, and vomiting in ten minutes. In about an hour there was paleness, with anxiety of countenance, coldness of surface, constant sickness, sense of heat and constriction in the throat, and burning pain in the stomach, with cramp. The irritability of the stomach continued in spite of treatment, and after two days there was salivation with mercurial fœtor. The gums acquired a deep bluish tint, and began to ulcerate. The patient died in about a week after taking the poison, without convulsions, and without suffering at any period from symptoms of cerebral disturbance. The principal appearances in the body were inflammation of the gullet, its mucous membrane at the lower part peeling off; the inner surface of the stomach near the two openings (cardia and pylorus) was covered with petechial spots; the small intestines were contracted, the inner coat reddened, and petechial spots were found, but chiefly in the large intestines. The parotid and submaxillary glands were swollen. Mercury was detected in the intestines. (See 'Med. Gaz.' vol. 39, p. 474.) Mr. Snoad, of Yoxall, has communicated to me the particulars of another case which was the subject of a trial for manslaughter at the Stafford Lent Assizes, 1862. A young man, æt. 27, by the mistake of a druggist, was supplied with turpeth mineral in place of Æthiop's mineral. He swallowed about two scruples of it, on an empty stomach, with a like quantity of cream of tartar and treacle. In ten minutes he was seized with violent vomiting and purging, the pulse was slow and small, the skin cold and clammy, and there was pain in the abdomen, especially in the region of the stomach. Under treatment the symptoms of

irritation abated, but never entirely subsided, and he died quietly on the eleventh day after taking the poisonous mixture. On inspection the principal appearances were softening of the mucous membrane of the stomach and intestines, with patches of inflammation and dark discoloration. A small portion of the liver yielded mercury when treated with copper and hydrochloric acid.

NITRATES OF MERCURY.—These are corrosive poisons which are used for various purposes in the arts. They are solid white salts, easily dissolved by cold water when there is a little excess of acid present. The acid pernitrate caused death in a case reported by Mr. Bigsley in the 'Medical Gazette,' vol. 6, p. 329. A butcher's boy dissolved some mercury in strong nitric acid, and swallowed about a teaspoonsful of the solution. Soon afterwards he suffered excruciating pain in the throat, gullet, and stomach:—there was great anxiety, with cold skin, small pulse, colic, and purging. He became gradually weaker, and died in about two hours and a half. On inspection, the throat, gullet, and stomach were found corroded and inflamed. Although he survived so short a time, the mucous membrane of the stomach was of a deep red colour. I have elsewhere related a case in which the application of the pernitrate of mercury to the throat as an escharotic, caused immediate death by asphyxia. ('Guy's Hospital Reports,' Oct. 1850, p. 206.) The acid nitrate of mercury has often been employed by accoucheurs as a local application in diseases of the neck of the uterus. In one instance in which it was thus used, the ordinary symptoms of mercurial poisoning showed themselves, and the patient appears to have suffered severely. ('Medical Gazette,' vol. 45, p. 1025.) In another case the application of the acid nitrate to the skin produced an eschar, and under the symptoms of mercurial poisoning caused the death of the patient on the ninth day. The mucous membrane of the stomach and intestines presented an arborescent redness, with patches of ecchymosis. Mercury was found in the liver. ('Ed. Monthly Journal,' 1864, p. 168.)

At the Leicester Summer Assizes, 1857, a girl was charged with administering nitrate of mercury to her mistress (*Reg.* v. *E. Smith*). The evidence showed that the accused had put the poison into some camomile-tea prescribed for the prosecutrix. Only a small quantity was taken, as the tea had a nauseous taste. The symptoms were: a burning sensation in the throat and stomach, violent vomiting, with severe pain in the abdomen. The woman recovered. In one case death took place under the usual symptoms from the external application of the nitrate in a liniment. ('Ed. Monthly Journal,' Aug. 1864, p. 167.) A man, æt. 32, suffering from chronic poisoning by the nitrate of mercury, was admitted into Guy's Hospital on the 10th December, 1863. He had been for four years engaged in packing the fur of rabbits, rats, and other animals, the dried skins of which had been previously brushed over with a solution of nitrate of mercury. For the first three years, he suffered only from a feeling of general weakness. About a twelvemonth since, he could not hold his hand steadily enough to shave himself, and he soon afterwards lost completely the control over the voluntary movements of his limbs. Three or four months before his admission, he had had slight twitchings of his muscles when in bed. He was not at all emaciated. He said he had been salivated for about three months, soon after he began his occupation of packing furs; but his gums were not tender, and he had no metallic taste in his mouth. A month before his admission he gave up his work. When he became a patient under Dr. Rees, I saw him, and his case was watched by Mr. Spurgin, one of my pupils. He could walk with assistance, but on standing or lying down he could not control his limbs, which trembled considerably. There were continued involuntary movements of his body and limbs, like those of chorea. He became much exhausted, owing to want of sleep; he perspired profusely. The urine was

high-coloured, but otherwise natural. Twelve ounces of it did not yield any mercury. No treatment appeared to give him rest or relief. Chloroform arrested the spasmodic movements, but only while he was under its influence. In five days he passed his urine involuntarily. He was more quiet and slept a little at night. He had difficulty in swallowing; became gradually weaker and died, apparently from exhaustion, on the 24th December, a fortnight after his admission. On inspection, the body was well nourished; the muscles were firm and healthy. The brain and spinal cord were carefully examined by Dr. Wilks, and found to be quite healthy. The lungs, heart, liver, spleen and kidneys, were free from any morbid appearance, or any change to indicate a cause of death. I made a chemical analysis of the brain, liver, and kidney. Six ounces of each organ were dried, and one-half of the dried residue, treated with hydrochloric acid and water, as elsewhere described (p. 286) gave, in 48 hours, on a small portion of copper gauze, a greyish white deposit, which yielded globules of metallic mercury by heat. The kidney yielded the largest sublimate; but the quantity obtained from each organ was small, and might be described as in microscopical traces. The globules from the brain and liver had an average size of 1-2600th of an inch; those from the kidney were larger. Dr. Whitley procured a portion of the fur similar to that which the man had been engaged in packing, and in a small quantity of this a soluble salt of mercury was readily detected. The case, which at first presented some difficulty in accounting for death, thus resolved itself into one of exhaustion as a result of chronic poisoning by mercury under somewhat unusual circumstances. It is probable that the man received the dust of the dried nitrate through the air which he breathed, as well as by contact with his mouth, nostrils, and skin. As other workpeople similarly engaged were not found to have suffered, this may have been a case of mercurial poisoning by idiosyncrasy.

Analysis.—When heated with dry or anhydrous carbonate of soda in a tube, the dry nitrate yields a sublimate of mercury. If heated alone, it is resolved into red oxide.

CHAPTER 22.

ON POISONING BY LEAD—SUGAR OF LEAD—SYMPTOMS—APPEARANCES AFTER DEATH—CHEMICAL ANALYSIS—LEAD IN ORGANIC MIXTURES—CARBONATE OR WHITE LEAD—CHRONIC POISONING. POISONING BY COPPER—BLUE VITRIOL—SYMPTOMS—APPEARANCES AFTER DEATH. POISONING BY OTHER COMPOUNDS OF COPPER—CHEMICAL ANALYSIS. COPPER IN ORGANIC LIQUIDS—IN ARTICLES OF FOOD.

SUGAR OF LEAD. *Acetate of Lead.*—This is more frequently taken as a poison that any of the other salts, although cases of acute poisoning by lead in any form are not common. The substance is commonly met with in solid heavy crystalline masses, white, or of a brownish-white colour; it resembles loaf-sugar in appearance, and has often been mistaken for it. It has also a sweet taste, which is succeeded by an astringent or metallic taste. It is very soluble in water. Four parts of distilled water at 60° will dissolve one part; it is much more soluble at a boiling temperature.

Symptoms.—Acetate or sugar of lead is by no means an active poison, although it is popularly considered to possess a virulent action. In medical practice it has often been given in considerable doses without any serious effects resulting. Sir R. Christison states that he has given it in divided doses to the amount of eighteen grains daily for eight or ten days without remarking any unpleasant

symptom, except once or twice slight colic. When, however, the quantity taken has been from one to two ounces, the following symptoms have been observed: a burning pricking sensation in the throat, with dryness and thirst, vomiting and uneasiness at the pit of the stomach, sometimes followed by severe colic. The abdomen is tense, and the parietes have been occasionally drawn in. The pain is relieved by pressure, and has intermissions. There is generally constipation of the bowels. If any fæces are passed, they are commonly of a dark colour, indicative of the conversion of a portion of the lead into sulphide. The skin is cold, and there is great prostration of strength. When the case is protracted, the patient has been observed to suffer from cramp in the calves of the legs, pain in the insides of the thighs, numbness, and sometimes paralysis of the extremities. The affection of the nervous system is otherwise indicated by giddiness, torpor, and even coma. A well-marked blue line has been noticed round the margin of the gums, where they join the teeth.

A remarkable series of cases of poisoning by acetate of lead has been reported by Mr. Bancks, of Stourbridge. ('Lancet,' May 5, 1849, p. 478.) By some accident, about thirty pounds of this substance were mixed at a miller's with eighty sacks of flour, and the whole was made into bread by the bakers and supplied as usual to their customers. It seems that no fewer than 500 persons were attacked with symptoms of poisoning after partaking of this bread. In a few days they complained of a sense of constriction in the throat and the pit of the stomach, violent cramping pains round the navel, rigidity of the abdominal muscles, a dragging pain in the loins, and cramp with paralysis of the lower extremities. There was obstinate constipation, and the urine was scanty and of a deep red colour. The pulse generally was slow and feeble; the countenance anxious and sunken, frequently of a peculiar livid hue; tongue, flabby; gums marked by a deep blue line. The surface was cool, and there was a general arrest of the secretions. Sickness was not a uniform symptom, and even when it existed at first, it speedily subsided. The mental faculties were undisturbed. Not one of the cases proved fatal, but among the more aggravated there was great prostration, with collapse, livid countenance, universal cramps, numbness, and other alarming symptoms. After apparent convalescence, some of the symptoms returned in a more aggravated form without any obvious cause, and for a long time the patients were out of health. Inflammation was not observed. Purgative medicines were found most effectual in the treatment. The quantity of acetate of lead taken by each person could not be determined, as, on analysis, the samples of bread were found to be unequally impregnated with the substance.

Even when the patient recovers from the first symptoms, the secondary effects often last for a considerable time. Mr. Gorringe has recorded the cases of two girls, each of whom swallowed an ounce of the acetate of lead by mistake. Soon afterwards they felt a burning pain in the mouth, throat, and stomach, and in a quarter of an hour they vomited freely: in half an hour, there was severe pain in the bowels, with purging. Under treatment recovery took place. ('Prov. Med. Journ.' April 1846.) After the lapse of a year, they both suffered from severe pain in the pit of the stomach, which was tender on pressure. Nothing could be retained on the stomach; and there was a choking sensation in the throat, with other constitutional symptoms. Paralysis and other symptoms of nervous disorder are, however, by no means necessary consequences. A girl who had swallowed sixty grains of acetate of lead, and had suffered severely from the primary symptoms, recovered in about three weeks without any paralysis or other disorder affecting the muscular system. ('Lancet,' April 4, 1846, p. 384.) This lead-palsy appears to be a more common consequence of chronic poisoning; *i.e.* of small doses taken at intervals.

Appearances.—In one acute case related by Dr. Kerchhoffs, the mucous

membrane of the stomach was removed in several places, especially near the intestinal opening; and most of the intestines were in a state of high inflammation. A trial for murder by this substance took place at the Central Criminal Court, in November 1843 (*Reg.* v. *Edwards*). The stomach and intestines are stated to have been found inflamed, and there were dark spots on the former. In animals, according to Dr. Mitscherlich, when the dose is large, the mucous coat of the stomach is attacked and corroded: this change appears to be purely chemical, and takes place in all parts of the body with which the salt of lead comes in contact. If given in a small dose, it is decomposed by the gastric secretions, and exerts no corrosive power on the mucous membrane. When the acetate of lead was given in a state of albuminate dissolved in acetic acid, death took place with great rapidity; but on inspection, the stomach was not found corroded. This corrosive action is a property of the neutral salt, and is not manifested when the dose is small, or when the poison is combined with an acid.

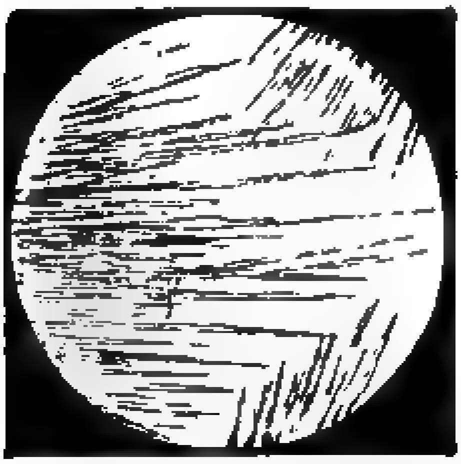
Quantity required to destroy life.—Nothing is actually known concerning the *fatal dose* of sugar of lead. The facts already detailed show that it may be taken in comparatively large quantities without producing serious effects. Thirty or forty grains have been given daily, in divided doses, without injury. The following additional cases, in some of which recovery took place under disadvantageous circumstances, prove that the acetate of lead is far from being a virulent poison. Dr. Iliff met with an instance in which *an ounce* was swallowed in solution: the symptoms were pain in the abdomen resembling colic, with vomiting, muscular rigidity, and numbness. It was three hours before any remedies were used, and five hours before the stomach-pump was employed; but the person recovered. In the second case, also, an ounce was swallowed: sulphate of magnesia was freely exhibited, and the stomach-pump was used. On the following morning there was slight excoriation of the gums, which were white, with a sensation of heat in the throat: the bowels were relaxed, probably from the effect of the medicine. The day following, there were pains in the legs and thighs, with restlessness and thirst. In a week the woman perfectly recovered. In a case which occurred to Dr. Alderson, a man swallowed an ounce of the acetate of lead in a drunken fit. There was violent vomiting, and the man recovered.

Chemical Analysis. Acetate of Lead as a solid.—1. If a portion of the powder is heated in a small reduction-tube, it melts, then becomes solid: again melts, acquiring a dark colour, and gives off vapours of acetic acid; a black mass is left in the tube, consisting of carbon and reduced metallic lead. No sublimate is formed. If heated on mica, yellow oxide of lead with reduced metal remains. 2. It is very soluble in water, even when cold; spring-water is turned milky by it, from the presence of carbonic acid and sulphates. 3. A small portion of the powder dropped into a saucer containing a solution of iodide of potassium acquires a fine yellow colour. 4. When dropped into caustic potash it remains white. 5. Into sulphuretted hydrogen water or sulphide of ammonium, it is turned black, in which respect it resembles the white salts of some other metals. 6. When the powder is boiled in a tube with diluted sulphuric acid, acetic acid, known by its odour and volatility, escapes. All these properties taken together, prove that the salt is the acetate of lead.

Acetate of Lead in solution.—If acetate of lead is presented in a state of solution, or if the salt is dissolved in water for the purpose of making further examination, we should note the following points:—1. A small quantity, slowly evaporated on a glass slide, will give slender white prismatic crystals, which are turned yellow by iodide of potassium, and black by sulphide of ammonium. The solution is said to be neutral; but I have found the common acetate of lead to have at the same time both an acid and an alkaline reaction, *i.e.* red-

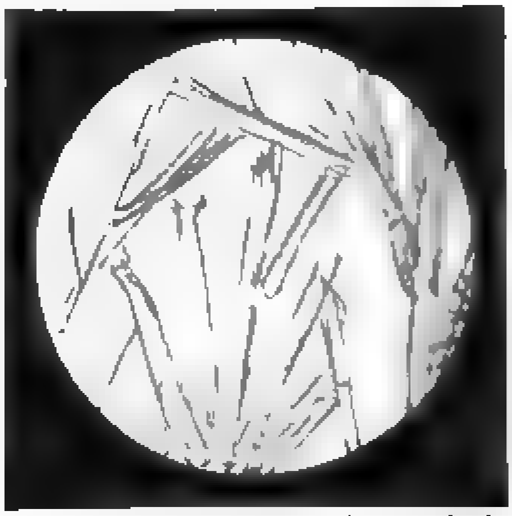
dening litmus-paper, and turning rose-paper green and turmeric brown, a circumstance which might create some embarrassment in an analysis. 2. *Diluted sulphuric acid* produces an abundant white precipitate, insoluble in nitric acid, but soluble in hydrochloric acid and in a large excess of potash.

Fig. 21.



Crystals of acetate of lead, magnified 30 diameters.

Fig. 22.



Crystals of acetate of lead, magnified 80 diameters.

3. It is precipitated of a bright yellow colour by the *Iodide of potassium*; the yellow iodide of lead is soluble in potash, forming a colourless solution. It is also dissolved by concentrated hydrochloric acid. 4. *Sulphide of ammonium* or sulphuretted hydrogen gas, produces a deep black precipitate, even when less than the 100,000th part of the salt is dissolved. 5. Place a few drops of the solution on clean platinum-foil in a platinum capsule, acidulate it with acetic acid, then apply through the solution, to the surface of the platinum, a thin polished slip of zinc:—crystals of metallic lead are instantly deposited on the zinc: by this method, a small quantity of the metal may be detected and collected. 6. Zinc alone placed in an acid solution slowly displaces the lead. The metal is thus obtained in a dark blue spongy mass.

Lead in Organic mixtures.—The acetate of lead is precipitated by many organic principles, especially by casein, albumen, and tannic acid. Thus we may have to analyze either an organic liquid containing lead, or a solid precipitate consisting of mucus or mucous membrane, intimately united to oxide of lead. If the liquid should be deeply coloured, and mixed with much organic matter, it may be submitted to dialysis in the manner already described (p. 215.) In this way if any lead is dissolved, a solution may be obtained so clear as to admit of the direct application of the tests. As a trial test some portion of the liquid acidulated with nitric acid and placed in a platinum capsule may be treated with zinc. When the zinc and the platinum come in contact, metallic lead is separated.

As all organic liquids, such as wine, vinegar, beer or cider, containing a salt of lead in solution, acquire a dark brown colour from sulphuretted hydrogen, this gas may be employed as a trial test. For this purpose a small quantity of the liquid diluted if necessary may be used. If thus detected in a portion, the whole of the lead may be precipitated from the solution as black sulphide of lead. The precipitate should be collected on a filter, washed and dried, then boiled for a quarter of an hour in a mixture of one part of nitric acid diluted with four parts of water. This has the effect of transforming it, at least in part, into nitrate of lead soluble in water. This liquid, when filtered, may be evaporated to dryness, and the residue dissolved in water, or it may be at once cautiously neutralized by potash (free from lead) or by ammonia, and the tests applied. If the quantity is too small for the application of all the tests, we may add sul-

phuric acid; should a white precipitate be formed, soluble in potash (free from oxide of lead), and this alkaline solution be again turned black by sulphide of ammonium, this is sufficient evidence of the presence of lead. Should there be no lead dissolved, we must decompose the solid and insoluble matters in nitric acid slightly diluted, at a boiling temperature, filter, and test the filtered liquid, previously neutralized; or we may evaporate to dryness, destroy the organic matter by heat, and redissolve the residue in nitric acid for testing.

In the tissues or the urine.—The organic matter, such as a part of the liver or other organ, should be dried and incinerated in a porcelain vessel. The ash should be heated with a small quantity of strong nitric acid, and then evaporated to dryness. The dry residue should be digested in a small quantity of distilled water (free from lead), filtered, and after it has been slightly acidulated with nitric acid, a current of washed sulphuretted hydrogen gas should be passed into it. The production of a brown colour or a brown precipitate, not readily dissolved by acids, indicates the presence of lead. Lead may thus be detected in the dry residue of urine and of spring or river water.

GOULARD'S EXTRACT. *Subacetate of Lead. Symptoms and Effects.*—This substance has caused death in at least four instances—one in France and three in England. Dr. Aldis describes the case of a woman, æt. 21, who swallowed about three-quarters of a pint of Goulard's extract of lead (strength not stated), having begun with small doses. When first seen she was in great agony. There was severe colicky pain in the abdomen, which she rubbed frequently, and the muscles of the belly were drawn inwards. The pulse was feeble, there was trembling of the hands, and she was in constant motion with her body from severe suffering. There was heat in the throat and abdomen with intense thirst, and a desire to vomit, but there was no vomiting or purging. A dose of sulphate of magnesia produced vomiting, and she recovered; but there remained obstinate constipation of the bowels. ('Lancet,' Jan. 14, 1860.) *Goulard Water* is made by adding one drachm and a half of this solution to a pint of water.

WHITE LEAD. *Carbonate of Lead. Symptoms.*—A case of poisoning by the carbonate of lead, was reported, in October 1844, to the Westminster Medical Society, by Dr. Snow. A child aged five years ate a portion not so large as a marble, ground up with oil. For three days he merely suffered from pain in the abdomen, and costiveness. On the third night, the child became rapidly worse, and there was vomiting. He died ninety hours after taking the poison, having passed some offensive motions of a greenish-black colour (probably from admixture with sulphide of lead) before he died. The mucous membrane of the stomach was much inflamed, and of a dark-red colour throughout. Lead could not be detected in the contents or tissues of the stomach, or in the matter vomited. It is remarkable that in this case so small a quantity should have proved fatal without exciting any marked symptoms of irritation in the first instance. A young man, æt. 20, was recommended to take chalk on account of acidity and heartburn. He took by mistake a piece of carbonate of lead, and ate about five or six drachms of it. After a few hours there was vomiting, and he complained of violent burning pains in the stomach. Twenty-four hours afterwards, when first seen, he suffered from severe pain, particularly in the pit of the stomach and at the navel. His face was red and swollen, his eyes were shining and prominent; his tongue and mouth dry and very red; abdomen distended and extremely sensitive to superficial pressure, whilst stronger pressure alleviated the pain; great thirst; the bowels were constipated. Sulphate of magnesia dissolved in water, with twenty drops of tincture of opium, was given to him, followed by larger doses of the same salt with an

oily emulsion, under which treatment the patient soon recovered. (Casper's 'Wochenschrift,' No. 36, 1844.) Most of the cases of poisoning by carbonate of lead have been of a chronic character.

Chronic Poisoning. Colica pictonum, or *Painter's Colic*, may be considered as the chronic form of poisoning by carbonate of lead. It is often difficult to trace the source of the poison, so slowly and insidiously are the effects manifested. In some instances the poison is received through the lungs, or skin, or by the saliva, although no physical or chemical evidence of this mode of introduction can be obtained. In another work ('On Poisons,' 2nd ed. p. 485) I have referred to cases in which colic and paralysis have occurred in persons who had slept in newly-painted rooms. Dr. Alderson mentions several instances of this kind. ('Lancet,' Oct. 30, 1852, p. 391.) I have myself suffered from a severe attack of colic as a result of sitting in a room for a few hours a day in which a large surface of canvas for an oil-painting had been covered with white lead and drying oil. The late Mr. J. Lizars, of Edinburgh, communicated to me the following case. A military officer, æt. 50, fond of painting in oil-colours, worked for some time in a room eight feet square which had a large stove in it. He was attacked with wrist-drop (paralysis) in December 1855, and soon afterwards with paralysis in both legs. It appears that his servant always ground his colours, mixed them, and cleaned his brushes. He had had an attack some years before; but from this, by laying aside oil-painting, he completely recovered. In these instances the emanations of lead must have been received through the lungs. Doubtless chemists might be found who would undertake to prove by ingeniously-devised experiments, that there could be no lead in the air of the room; and, coupling their results with the fact that few artists are known to suffer from such symptoms, would contend that lead was not the cause. The symptoms, however, were of the character peculiar to lead-poisoning, and as they disappeared on the removal of the patient to another atmosphere, there could be no doubt about the cause. These insidious effects of lead should be borne in mind by those who deny that any noxious emanations can escape from arsenical papers in inhabited rooms, merely because the greater number of persons who live in them do not suffer, and because some chemists have affirmed that they could detect no arsenic in a volatile state in the atmosphere of the room. Among white-lead manufacturers the carbonate finds its way into the system either by the skin, the lungs, mouth and nostrils, or all these channels together; it is diffused in a fine powder through the atmosphere, and thus enters into the lungs. It has been remarked in France, that, in manufactories where the powder was ground dry, not only have the labourers suffered, but horses, dogs, and even rats, have died from its effects: the rats have been affected with paralysis in their hind legs. Since the practice has arisen of grinding the carbonate of lead in water, cases of colica pictonum have not been so numerous. A fatal instance of this kind of poisoning is reported in the 'Pharm. Jour.' 1865, 1, 38.

Men employed in the manufacture of pottery or glazed cards are liable to attacks of this kind. There are numerous other cases in which lead, or its preparations, by mere contact with the skin, have been known to produce the usual results of lead-poisoning. The late Mr. Scanlan communicated to me a case in which an infant was paralyzed by reason of its having been, every morning, washed with water containing a finely-diffused oxide and carbonate of lead. The late Dr. Todd has described the case of a man in King's College Hospital who suffered from lead-palsy: he had been a potman, and the palsy was attributed to the constant handling and cleaning of pewter pots. ('Med. Gaz.' vol. 48, p. 1047. For another case, see 'Lancet,' Jan. 21, 1860, p. 60.) Dr. Johnson, of King's College Hospital, treated a case of lead-poisoning in which the cause was traced to the handling of vulcanized rubber, impreg-

nated with lead to give it a dark colour. The man was a trunk-maker, and used this material in his trade. ('Pharm. Jour.' 1870, p. 426.) The mere handling of lead or its oxides, is therefore sufficient to produce all the effects of chronic poisoning. I have been informed of a case in which a tea-dealer was seized with symptoms of lead-poisoning, and the cause remained long unsuspected, until he admitted that, in the course of his trade, he had the idle habit of often placing pieces of tea-lead in his mouth, and crushing the metal between his teeth. Cattle have suffered from lead-poisoning, and died under the following circumstances: in grazing, they have swallowed the thin splashes of lead left as a result of the volunteer firing at the butts. In some cases in which I was consulted in February 1865, it appeared that in the bodies of three cows, two of which had died suddenly without any apparent disease, and the other had been killed, the splashings of lead were found in the stomachs. The lead adhered closely to the mucous membrane, which came off with the metal. Cattle in the Mendip Hills have been frequently poisoned by taking with their food the waste slag, in the form of a fine dust.

One cause of lead-palsy among infants may be the use of farinaceous food wrapped in lead-foil having a thinly tinned surface, sold as patent tin-foil; I have found such infants' food to be strongly impregnated on the outside with carbonate of lead. ('On Poisons,' 2nd ed. p. 505.) Snuff and tobacco, chocolate, and other substances in ordinary use, are frequently wrapped in this spurious tin-foil. If the articles are kept in a damp place, they may thus become impregnated with carbonate of lead. In a case which was under Dr. Rees at Guy's Hospital, in January 1861, no source of lead could be traced, although the symptoms were those of chronic lead-poisoning, and lead was found in the urine. Cosmetics and hair-dyes containing preparations of lead, commonly called hair-restorers (!), may also produce dangerous effects. I have met with an instance in which paralysis of the muscles on one side of the neck arose from the imprudent use of a hair-dye containing litharge. These hair-dyes or 'hair restorers' are sometimes solutions of acetate of lead of variable strength, in perfumed and coloured water. In other cases they consist of hyposulphite of lead dissolved in an excess of hyposulphite of soda. In one instance the continued use of such a dye is reported to have proved fatal, and lead was found in the liver and one of the kidneys. ('Pharm. Jour.' Nov. 1869, p. 304; also Jan. 1869, p. 440.) Mr. Lacy has pointed out the injury to health which is likely to follow the use of white lead as a cosmetic by actors. The glazed white leather lining of hats is strongly impregnated with carbonate of lead, which may penetrate the body by the perspiring skin. Other facts connected with this form of lead-poisoning, will be found in the 'Medical Times and Gazette,' Aug. 1852, p. 223; 'Ann. d'Hyg.' 1859, 1, pp. 95, 296: also 'Ann. d'Hyg.' 1861, 1, pp. 342, 389; and 1870, 1, 72.

Symptoms and Appearances.—The symptoms of chronic poisoning by lead are well marked. There is at first pain with a sense of sinking commonly in or about the region of the navel, the seat of the colon, hence called colic. Next to pain there is obstinate constipation, retraction of the abdominal parietes, loss of appetite, thirst, fœtid odour of the breath, and general emaciation, with paralysis of a peculiar kind affecting the extensor muscles, and causing a dropping of the wrist, or showing itself in a general paralysis of the limbs. The skin acquires a sallow or dusky colour, generally well marked in the face, and the patient experiences a sweetish, styptic, or astringent taste in the mouth. A symptom of a peculiar nature was first pointed out by the late Dr. Burton ('Med. Gaz.' vol. 25, p. 687), namely, a *blueness* of the edges of the *gums*, where these join the bodies of the teeth: the teeth are of a brownish colour. Dr. Chambers affirms that this blue line on the gums is an early consequence of lead-poisoning in any form, and is a distinguishing sign of lead-colic. A gas

engineer, who had worked for eighteen years in his trade, had during this time used a quantity of red and white lead for various purposes. It was, however, only within the last eighteen months of his work that he had suffered from the usual symptoms of lead-poisoning. ('Lancet,' Jan. 21, 1860, p. 60.) It is worthy of note that, although this person had been so many years exposed to the causes of lead-disease, he did not suffer from any symptoms until the latter part of the time. A blue mark round the edge of the gums has been noticed in some cases of poisoning by mercurial preparations; and it is possible that in an advanced stage of chronic poisoning by lead, it may be absent—as where, for example, the individual has ceased to expose himself to emanations of lead (see case by Mr. Fletcher, 'Med. Times,' Feb. 14, 1846, p. 395). Many facts tend to show that in general it is an early symptom. Chronic poisoning by lead often kills the patient; after death the large and small intestines have been found much contracted, and their coats thickened. These changes have been especially observed in the colon.

The most frequent cause of chronic lead-poisoning is the use of water kept in leaden cisterns or pipes, or the careless employment of white or red lead as a cement for pipes. For an instructive series of cases showing the effects of water poisoned with lead, I must refer the reader to a paper by Dr. de Mussy, published in the 'Dublin Quarterly Journal' for May 1849; also 'Medical Gazette,' vol. 44, p. 260. These cases occurred at Claremont, among the members of the ex-Royal Family of France. The effects were traced to the use of pure water which had acquired an impregnation of lead by contact with that metal, in the proportion of one grain to the imperial gallon. Thirteen out of thirty-eight persons were affected, and to such a degree that the nails of the toes and fingers acquired a bluish discoloration. The children of the family did not suffer. This is perhaps the smallest quantity of lead in water accurately recorded to have produced the effects of poisoning. No symptoms appeared until after the water had been in use for a period of from five to seven months, and more than half of those who used the water escaped any ill effects. According to the late Mr. Herapath, the symptoms of lead-poisoning have been produced in a community by so small a quantity as one-ninth of a grain of lead in a gallon; and Dr. J. Smith, of Aberdeen, concludes from his investigations that the limit of manifestly deleterious action would seem to be somewhere between one-tenth and one-twentieth of a grain in a gallon (Dr. Penny, 'Report on Loch Katrine Water,' p. 107). Waters collected from lead-mine districts generally contain lead either in suspension or in solution. In one of these proposed to be supplied to Wrexham in North Wales, I found the proportion of lead to be one-eleventh of a grain in a gallon—a quantity which might prove noxious to some portion of a town population, as a result of long-continued use. A medical officer of health deposed before a Committee of the House of Lords, in May 1864, that there was less than one-fourteenth of a grain of lead in a gallon, and that this proportion, if present, would do no injury, while one-twelfth of a grain would be noxious, although the data upon which this sharply-defined distinction was based were not made public. According to Sir R. Christison all waters act more or less upon lead, and as a limit of safety for persons using a water for domestic purposes, the proportion of lead should not exceed one-millionth part, or about one grain in fifteen gallons of water. ('Pharm. Jour.' April 1872, p. 852.) A water which acts chemically on the metal may soon cease to act by reason of a hard deposit taking place in the interior of the pipes, and the metal is thus protected from further chemical action. When the water, before entering the pipes, is already provided with so much lead that it easily admits of detection in a pint, a slight additional impregnation will suffice to render it poisonous. A safe sanitary rule would be that suggested by the late Dr. Penny. All lead-contamination is

objectionable, and no degree of it can be considered safe. Lead is an accumulative poison, and affects some persons powerfully in the smallest quantities. For an account of the various conditions under which water is liable to be poisoned with lead, and the effects produced by the use of such water, I must refer the reader to my work 'ON POISONS,' p. 506. An evil practice has lately sprung up of substituting for pure block-tin an alloy of tin and lead, in the so-called tinning of iron and copper utensils. The small supply-boilers of cisterns, supposed to be tinned, are really covered with a layer of pewter; and lead may thus be conveyed into food and water under circumstances not suspected. M. Gobley has fully pointed out the danger of this practice in reference to public health. ('Ann. d'Hyg.' 1869, 1, 237.)

In 1850 it was proposed to refine sugar by the use of a salt of lead. It was found that the proportion of lead-salt contained in sugar refined by this process varied from two-tenths to four-tenths of a grain in four pounds. The Commissioners of Inland Revenue, considering that this small quantity might affect the public health, referred the consideration of the question to the late Dr. Pereira, Dr. Carpenter, and myself. We came to the conclusion that even this degree of contamination of such a universal article of food as sugar, was objectionable, and that such a process of manufacture should be as far as possible prohibited.

Analysis.—Carbonate of lead is a solid white powder, insoluble in water, and immediately blackened by sulphuretted hydrogen or sulphide of ammonium. 1. When heated on platinum, it leaves a residue of yellow or orange-coloured oxide of lead, soluble in nitric acid. 2. The carbonate is easily dissolved with effervescence by diluted nitric acid—a fact which shows that it contains carbonic acid. The oxide of lead, combined with nitric acid, may be readily detected in the filtered solution by the tests already mentioned. This salt of lead is sometimes contained in small proportions in loaf-sugar, owing to the moulds in which the loaf is set to crystallize being painted with white lead, and a portion being thus mechanically taken up. This is a noxious practice, and ought to be prohibited. Water which is suspected to contain a small quantity of this compound may be tested for lead by the process described for the tissues at p. 297. At least an imperial pint should be made the subject of experiment.

OXIDES OF LEAD.—The yellow oxide (massicot), and the brown oxide (peroxide), are but little known except to chemists. *Litharge* and minium or *red lead* are, however, much employed in the arts, and have sometimes given rise to accidental poisoning. In October 1843, a woman who had swallowed two-and-a-quarter ounces of the red oxide of lead, was admitted into Guy's Hospital. No symptoms appeared for nine hours. There was then colicky pain, with urgent vomiting, followed by headache and general tenderness of the abdomen. She entirely recovered in about twelve days. ('Guy's Hospital Reports,' October 1850, p. 209.) In March 1870, owing to an accident, some red lead became mixed with a quantity of beer at a brewery at Guildford. Several persons who drank this beer suffered from lead-poisoning. One man died, but it was probable that disease of the lungs was the immediate cause of death. Colicky pains and a blue line on the gums, with constipation, were well-marked symptoms among the patients. In the course of a month as many as twenty-seven cases of lead-colic came under treatment. ('Lancet,' 1870, 1, 428 and 495.)

Liquids used for culinary or dietetic purposes, especially if they contain a free *acid*, are liable to become impregnated with oxide of lead, derived from the glaze of the vessel in which they are kept, and thus form poisonous salts. If vinegar is used, acetate of lead may result. Litharge-glaze is also easily dissolved by alkaline or *fatty* substances. The eating of dripping, or the fat of meat baked in a newly-glazed vessel, has been known to give rise to a slight

attack of colic; while the symptoms were referred by the person to some substance mixed with the food. (For cases of this kind see the 'Medical Gazette,' vol. 47, p. 659; also 'Lancet,' 1860, 1, 962.) I am indebted to Mr. Procter, of York, for the particulars of a case of some novelty, in reference to the contamination of food with lead. In July 1852, four men partook of rhubarb-pie and milk for supper; shortly afterwards they were all seized with violent vomiting and intense colic. A portion of the vomited matters and food was examined by Mr. Procter, and lead was detected in them. The only source to which the lead could be traced was the glaze of the pans in which the milk was kept. *Cider* is sometimes poisoned with lead owing to the use of leaden vessels or pipes in its manufacture. An instance of the fatal effects of cider so poisoned is reported to have occurred in Worcestershire in January 1864, and another fatal case occurred in Herefordshire in 1867. Eight men were seized with symptoms of lead-poisoning, and one died. The late Mr. Herapath found one grain of lead-salt in a gallon of the cider. The leaden pipe was found corroded by the acid in the cider. Lead pipes are largely used by publicans for the supply of beer. It is possible, therefore, if the beer is acid, and is allowed to remain some time in the pipe, the first portions drawn may acquire an impregnation of lead, which might give rise to colic and other unpleasant symptoms. When liquids of this kind are impregnated with oxide of lead, the fact is immediately known by their being turned of a brown colour by sulphuretted hydrogen. (See a paper by Dr. Waldmann, of Erfurt, Horn's 'Vierteljahrsschrift,' 1870, 1, 268.) All newly-glazed vessels yield traces of lead, more or less, on boiling in them vinegar, pure acetic acid, or a solution of pure potash. In this manner the poisonous nature of the glaze may be tested, the oxide of lead being dissolved either by the acid or the alkali. I have found common acetic acid itself containing, as impurity, two per cent. of acetate of lead. I have also found lead in citric and tartaric acids, and in salts which have been crystallized in leaden pans. Litharge was formerly much used to remove the acidity of sour *wine*, and to convey a sweet taste. Acetate of lead, or some other vegetable salt of the metal, is in these cases formed; and the use of such wine may be productive of alarming symptoms. Many years since a fatal epidemic colic prevailed in Paris, owing to this cause: the adulteration was discovered by Fourcroy, and it was immediately suppressed. Wine thus poisoned is known by its being blackened by sulphuretted hydrogen.

Snuff has been adulterated with red lead in order to improve its colour. Two instances of chronic poisoning by lead have come under my notice, as a result of the presence of oxide of lead in snuff. One sample contained the oxide in large proportion. This noxious adulteration has frequently given rise to paralysis and other forms of lead-disease. ('Med. Gaz.' vol. 32, p. 138; also, 'Ann. d'Hygiène,' 1831, 2, 197; and 'Lancet,' Jan. 21, 1860, p. 60.) It is readily detected by incinerating a small quantity of the snuff in a porcelain capsule and digesting the ash in warm nitric acid. This may be afterwards diluted with water and filtered for the application of the tests for lead. Dr. Sonnenkalb, of Leipsic, considers that snuff frequently acquires an impregnation of lead, by reason of the coverings of lead in which it is packed. He has collected nineteen cases of this form of chronic poisoning: in fourteen of these there was paralysis, and in five there were symptoms of gastric disturbance. The arms were most commonly affected with paralysis in the extensor muscles, which wasted. In twelve cases there was a blue colour of the gums. All suffered from colicky pains and constipation. The poisoned snuff had been used for a period of from six months to twenty years: and on leaving it off, the patients improved rapidly, and eventually recovered. (See also a paper by Dr. Garrod, 'Lancet,' Dec. 1870, p. 781, and 'Pharm. Jour.' 1870, p. 465; and another by Dr. Flinzer, Horn's 'Vierteljahrsschrift,' 1868, 2, 175.)

Preparations of Copper.

All the salts of copper are poisonous. The two most commonly known in commerce are the Sulphate or Blue Vitriol, and the Subacetate or Verdigris. The former has been frequently taken and administered in large doses for the purpose of suicide and in attempts at murder. In the latter case the attempt has been immediately discovered, owing to the strong metallic taste possessed by the salt. This would in general render it impossible that the poison should be taken unknowingly. With the exception of these salts poisoning by copper is usually the accidental result of the common employment of this metal for culinary purposes. There is one copper salt—the Arsenite (Scheele's Green)—which chiefly owes its poisonous properties to arsenic. This has been elsewhere considered (p. 273).

Blue Vitriol. *Sulphate of Copper. Symptoms.*—Sulphate of copper has been frequently given for the purpose of procuring abortion. In doses of half an ounce and upwards, it acts as a powerful irritant on adults, and a much smaller quantity would suffice to destroy infants or children. The salt speedily causes vomiting of the most violent kind; this sometimes expels the poison from the stomach, and the person recovers. The *vomited* matters are remarkable for being generally of a *blue* or *green* colour; and broken crystals of blue vitriol were discovered in them, in a case in which the poison was taken in a loosely pulverulent state. If the green colour of the vomited liquids is owing to altered bile, it will not acquire a blue tint on adding to a portion of the green liquid a strong solution of ammonia; but if it be caused by a salt of copper, this change of colour will serve to indicate the fact. There is head-ache, pain in the abdomen, with purging; the pain is of a colicky character; and in aggravated cases, there are spasms of the extremities and convulsions. Dr. Percival met with an instance in which violent convulsions were produced in a young woman by two drachms of the sulphate of copper. Paralysis, insensibility, and even tetanus, have preceded death, when the poison was administered to animals. Among the symptoms casually met with in the human subject, may be mentioned jaundice. This has been observed to attend poisoning by the sulphate, as well as by Scheele's Green. The medicinal dose of sulphate of copper as an emetic, is from five to fifteen grains, and as a tonic from one to three or four grains.

There are but few instances in which this poison has proved fatal in the human subject. In 1836, a girl, sixteen months old, put some pieces of *Blue stone* (sulphate of copper), which were given to her to play with, into her mouth. In a quarter of an hour the child vomited a blueish-green coloured matter, with pieces of sulphate of copper in it; the skin was alternately cold and hot, but there was no purging. The child died in *four hours*, without being convulsed, but it was insensible before death. ('Medical Gazette,' vol. 18, p. 742.) Unfortunately no inspection of the body was made; and yet, in the event of murder being committed by the administration of this substance, it will be somewhat unreasonably expected that medical witnesses should be fully acquainted with the appearances produced by it in the stomach and bowels.

Appearances.—In poisoning with the salts of copper, the mucous membrane of the stomach and intestines has been found more or less thickened and inflamed in the few fatal cases which have been hitherto examined: the membrane has been also found destroyed and softened in poisoning with verdigris. The gullet has presented an inflammatory appearance. In a case of poisoning with verdigris, quoted by Orfila, the stomach was inflamed and thickened, especially towards the intestinal opening, the orifice of which, owing to the general thickening, was almost obliterated. The small intestines were throughout inflamed, and perforation had taken place, so that part of the green liquid

was effused into the abdomen. The large intestines were distended in some parts, and contracted in others, and the rectum was ulcerated on its inner surface. ('Toxicologie,' vol. 1, p. 787, 5th ed.) The lining membrane of the intestines has been found throughout of a deep green colour, owing to small particles of verdigris adhering to it. It has been said that this is an uncertain character of poisoning by copper; since a morbid state of the bile often gives a similar colour to the mucous membrane of the stomach and duodenum. This objection cannot apply when the green colour is found in the gullet, and throughout the intestines; and, under any circumstances, the evidence from the presence of a green colour would amount to nothing in the judgment of a prudent witness, unless copper were freely detected in the parts so coloured. It is well to remember that the green stain, if due to copper, will be turned blue by ammonia.

VERDIGRIS. *Subacetate of Copper.*—This salt produces *symptoms* somewhat similar to those caused by the sulphate. There is a strong styptic metallic taste, with a sense of constriction in the throat, followed by severe colicky pains, vomiting of a green-coloured liquid, and purging, with violent straining (tenesmus). In a case reported by Pyl, a woman who swallowed *two ounces* of verdigris died in three days: in addition to the symptoms above described, there were convulsions and paralysis before death. Niemann relates that a female, aged 24, swallowed *half an ounce* of verdigris, and died under symptoms of severe irritation of the stomach in sixty hours. ('Taschenbuch,' p. 458.) In consequence of the great uncertainty of its operation, subacetate of copper is not employed internally.

The SUBCHLORIDE and CARBONATE are also irritant poisons.

Chronic poisoning by copper is occasionally seen among workers in this metal and its salts. The poison enters the system partly by the lungs in the form of dust, and partly by the skin in handling the metal or its salts. The marked symptoms are a coppery taste in the mouth, giddiness, pain in the bowels, vomiting, occasional diarrhœa, and wasting of the body. Dr. Clapton has pointed out another symptom, namely, a green line on the margin of the gums. He met with this in a sailor and in some working coppersmiths. ('Med. Times and Gazette,' June 1868, p. 658.) Two of these cases I saw in 1868. The green line was well marked. The men brought with them a hammer used in their work. It had a greenish colour, and this was shown by tests to to be owing to copper. The perspiration from the hands in working had converted the copper into subchloride, and thus led to its absorption by the skin. Several cases of chronic poisoning by copper among coppersmiths have been treated by Dr. Cameron of Liverpool, but this symptom was not noticed. ('Med. Times and Gazette,' 1870, 1, 581.)

Chemical Analysis of the Salts of Copper.—The salts of copper are generally known by their colour; whether in the solid state or in solution, they are either blue or green. The salts of one other metal are also of a green colour, namely, nickel; but there are striking chemical differences between the salts of this metal and those of copper. There are *three* very *soluble* salts of copper; two of these are blue, the sulphate and nitrate, and one green, the chloride. The solutions of the cupreous salts have generally an acid reaction. The salt should be dissolved in water, diluted, and the following tests may then be applied:—

Tests.—1. *Solution of ammonia*: this gives, in a solution of copper, a bluish-white precipitate, which is soluble in an excess of the test, forming a deep violet-blue liquid. 2. *Ferrocyanide of potassium* gives a rich claret-red precipitate; if the quantity of copper is small, the liquid acquires merely a light-red colour; if large, the precipitate is of a deep red-brown colour, and of a gelatinous consistency. The ferrocyanide of potassium will act on the violet-blue

solution produced by ammonia, provided it is diluted, and an acid is added (sulphuric) to neutralize the ammonia. One portion of the liquid may thus be tried by the two tests. 3. *Sulphuretted hydrogen gas*, or sulphide of ammonium, gives a deep chocolate-brown precipitate, even in an acid solution; or if the copper is in small proportion, merely a light-brown colour. 4. A slip of *polished iron* (a common needle) suspended by a thread in the liquid slightly acidulated with sulphuric acid is speedily coated with a layer of copper, even when the salt is in very small proportion. If the needle is left for some days in the liquid, the iron will be slowly removed, and a hollow cylinder of metallic copper will remain. This may be dissolved in diluted nitric acid, and tested with the foregoing tests; or the iron, coated with copper, may be at once immersed in ammonia and exposed to air. The liquid then becomes slowly blue. Half a grain of sulphate of copper dissolved in sixteen ounces of water may be thus easily detected. It was long since proposed by Orfila to substitute phosphorus for polished iron. This substance most effectually separates metallic copper from its salts, even when they are dissolved in organic liquids, but polished iron is preferable. 5. *The Galvanic test.*—If a few drops of the copper solution are placed on platinum-foil, slightly acidulated with a diluted acid, and the platinum is then touched through the solution with a thin slip of zinc-foil, metallic copper, of its well-known red colour, is immediately deposited on the platinum. When the quantity of copper is small, there is merely a brown stain; but a blue liquid is formed by pouring on it ammonia, and exposing it to air. A coil of fine platinum and zinc wire may be substituted for the foil.

Copper in Organic liquids.—The oxide of copper is liable to be precipitated by certain organic principles, *e.g.* albumen, fibrin, casein, and mucous membrane: but some of these organic compounds are easily dissolved by acids, or even by an excess of the solution of cupreous salt. A portion at least of the salt of copper is, therefore, commonly held dissolved. In such cases there is one peculiar character possessed by these liquids, *i.e.* they have a decidedly *green colour*, even when the copper-salt is in a far less than poisonous proportion. The sulphate of copper, used in medicine and chemistry, sometimes contains traces of arsenic. About ten grains of the crystallized sulphate will be sufficient to yield evidence of the presence of this poison. When the sulphate has been given as an emetic, traces of arsenic may be found in the contents of the stomach or in the matters vomited. Sulphate of copper is occasionally met with as a fraudulent addition to bread. (Horn's 'Viertel-Jahrsschrift,' 1870, 1, 322. Also 'Med. Times and Gaz.' 1871, 1, 509.)

A polished needle or fine iron wire may be used in these liquids as a trial-test for the presence of the salts of copper. If in large quantity, the copper may be precipitated by sulphuretted hydrogen, the sulphide collected, dried and converted into a soluble sulphate by the action of strong nitric acid. If in small quantity, the following is the most expeditious method of obtaining copper from any organic liquid which contains a soluble poisonous salt of this metal. Having filtered the liquid, let a portion of it be placed in a clean platinum capsule or crucible. A few drops of diluted sulphuric acid should be added and a slip of zinc-foil introduced. Wherever the platinum is touched by the zinc, metallic copper of its ordinary red colour is deposited; and after having in this way coated the platinum capsule, the surplus liquid may be poured off and the capsule well washed out. The copper is then dissolved in nitric acid, and the tests may be applied to the solution after the excess of acid has been driven off by heat. In place of nitric acid and heat a strong solution of ammonia may be used in the cold. Under exposure to air the metal is oxidized and dissolved in a few minutes, forming a blue solution. The ammoniacal solution may be neutralized with diluted sulphuric acid, and the ferrocyanide of potassium then applied. The red colour of the metal deposited on platinum,

is characteristic of copper; but should any doubt exist, this may be removed by placing a polished needle in the ammoniacal solution and adding diluted sulphuric acid to neutralize it. The needle is immediately covered with a layer of red copper. Not much importance should be attached to the discovery of mere traces of this metal either in the body or in articles of food. Copper, if looked for, may be found in many cases in the tissues and in food, under circumstances quite unconnected with poisoning. It was found in a mutton chop procured fresh from a butcher's shop.

In the tissues or urine.—Dry and incinerate the organic matter. Digest the residuary ash in pure hydrochloric acid by heat, and then evaporate nearly to dryness. The residue may be dissolved in a small quantity of water, and a polished needle immersed for some hours. The metallic deposit, if any, on the needle, may be recognized as copper, either by its colour or by the action of ammonia.

Copper in food.—The medico-legal history of poisoning by copper would be incomplete without some remarks on the action of certain articles of food on this metal, when it is used for culinary purposes. This is not an unfrequent form of accidental poisoning. The symptoms rarely appear until after the lapse of three or four hours, or even a much longer period. There is commonly nausea, with colicky pains and cramps in the limbs. It results from the experiments of Falconer and others, that metallic copper undergoes no change by contact with *water*, unless the air is present, when a hydrated carbonate, mixed with oxide of copper, is formed. If the water contains an acid such as vinegar, or common salt, or if there is oily or fatty matter in contact with the metal, then the copper is more rapidly oxidized, and the liquor or fat acquires a green colour. If the copper vessel is kept perfectly clean, and the food prepared in it is allowed to cool in other vessels, there is not much risk of its acquiring a poisonous impregnation: nevertheless, no acid, saline, fatty, or oily liquid should be prepared as an article of food in a copper vessel. (See 'Ann. d'Hyg.' 1832, 1, 102.) Under the influence of heat and air, a portion of copper becomes dissolved, and the oily or other liquid acquires a green colour. The preparation of fruits, such as preserves, in copper vessels, is necessarily attended with some risk; for, on cooling, a green crust is apt to form on the copper, just above the surface where the air and acid liquid meet. Some liquids, while boiling, appear to be little liable to this impregnation: thus, coffee, beer, milk, and tea have been separately boiled for two hours together, in a clean copper vessel, without any portion of the metal being taken up by either of the liquids. (See 'Falconer, on the Poison of Copper,' p. 65, London, 1774; also 'Orfila,' vol. 1, p. 611.) Accidents of this kind are usually prevented by lining the copper vessel with tin; but in very large boilers this plan is not always adopted; cleanliness alone is trusted to, and this, when properly observed, is a sufficient preventive. In reference to culinary vessels the tin is often worn away, and the corroded copper is thus exposed to the action of any acids contained in the food. Mr. Todd, Coroner for Hants, communicated to me the following case (Aug. 1866). Some rhubarb-stems were stewed in a copper vessel imperfectly tinned and dirty, and were supplied to a family for dinner. The children and their governess partook of it—the latter very freely. All were taken ill. The governess suffered most; there was violent sickness, with other symptoms of irritation. She recovered partly under treatment, but had a relapse, and died from the effects of the poisoned food. The oxalic and malic acids in the vegetables probably acted strongly on the copper.

In July 1866, a remarkable set of cases occurred in the family of a Mr. Corrie, Itchen Abbas, Hants, in which twelve or more members of the family suffered from symptoms of poisoning similar to those produced by copper in food. A badly tinned copper vessel had been used for cooking the food, with much

salt. One patient, an old man, æt. 90, died after three weeks, the others recovered. The cook was charged with wilful poisoning, but was subsequently liberated. She brought an action against her master (*Tully* v. *Corrie*, Queen's Bench, Nov. 1867), but this resulted in a verdict for the defendant. A full account of this case will be found in the 'Guy's Hosp. Rep.' 1866, p. 329. A set of cases is reported to have occurred at Geneva in 1870, in which ten persons were taken ill with symptoms of irritant poisoning, and four died. It was found that the food had been cooked in a copper utensil containing a large quantity of verdigris. ('Pharm. Jour.' August 1870, p. 158.) A fatal case of poisoning by copper is reported in the same journal for 1870, p. 874. Copper was found in small quantity in the body. Dr. Waldemann, of Erfurt, has lately published an elaborate paper on the effects of copper and zinc and their alloy brass, when used for culinary utensils. (Horn's 'Vierteljahrsschrift,' 1870, 1, 247.)

The tin used for lining copper vessels is frequently alloyed with a large proportion of lead, and thus lead-poisoning may be substituted for poisoning with copper. According to Paasch, of Berlin, many of the accidents attributed to this form of cupreous poisoning are really due to other causes. (Casper's 'Vierteljahrsschrift,' 1852, B. i. H. i. S. 78.) It has been elsewhere stated that all the ordinary copper employed for culinary utensils, contains arsenic. In those cases in which the metal is converted into insoluble oxides or salts by acids or fat, the arsenic may be found in an insoluble form in the green incrustation produced. When copper thus forms an insoluble salt, I have not found any arsenic dissolved.

It has been stated that an impure gold alloy used by some of the lower class of dentists has been so largely composed of copper as to affect the health of those who have used the plates for the support of artificial teeth. The acid and salts in the saliva facilitate the production of a poisonous salt of copper, and probably set free arsenic.

In the making of preserved *fruits* and vegetable *pickles*, the salts of copper (blue vitriol) are sometimes used for the purpose of giving a rich green colour! Many of the green pickles sold in shops are thus impregnated with the vegetable salts of this metal, to which they owe their bright grass-green colour. If the fruit or pickle is placed in a solution of ammonia, and copper is contained in it, the substance is speedily turned blue. The iron-test is, however, more delicate. A bright needle immersed in the pickle, or plunged into the solid, will be speedily coated with copper. The quantity of copper contained in such articles may not be sufficient to cause fatal effects; but serious symptoms of gastric irritation are sometimes produced, and in young persons these may assume an alarming character. (See 'Falconer,' p. 87.)

CHAPTER 23.

TARTAR EMETIC—SYMPTOMS—APPEARANCES—CHRONIC POISONING—CHEMICAL ANALYSIS—CHLORIDE OR BUTTER OF ANTIMONY—POISONING BY SULPHATE AND CHLORIDE OF ZINC—PREPARATIONS OF TIN—SILVER—GOLD—IRON—BISMUTH AND CHROMIUM—BICHROMATE OF POTASH—THALLIUM.

Tartar Emetic. Tartarated Antimony. Stibiated Tartar. *Symptoms and Effects.*—When this substance is taken in a poisonous dose, a strong metallic taste is perceived in the mouth during the act of swallowing. There is great heat and constriction of the throat, with difficulty of swallowing, violent burning pain in the region of the stomach, followed by incessant vomiting,

profuse purging, faintness and extreme depression. The pulse is small and rapid, sometimes imperceptible; the skin cold, and covered with a clammy perspiration; and the respiration is painful. Should the case prove fatal, death may be preceded by giddiness, insensibility, great prostration of strength, and sometimes violent spasms of the muscles of the extremities, which may assume either a clonic or a tetanic character. Such are the symptoms in an acute case of poisoning by this substance.

The *quantity* actually required to destroy life is unknown. It will probably depend in some degree on whether active vomiting and purging have been excited or not; for these symptoms have not been present in all cases. Doses of from twenty grains to one ounce have been taken without destroying life, although alarming symptoms of irritation have followed. In one case, related by Orfila, a man, æt. 50, took forty grains of tartar emetic, and died in about four days. This was the only one out of five cases of poisoning by this substance quoted by Orfila which proved fatal. ('Orfila,' vol. 1, p. 480.) Dr. Beck mentions a case in which fifteen grains of tartar emetic in solution killed a child in a few weeks: vomiting and purging were among the symptoms and these were followed by convulsions and death. This case proves that a patient is not always saved by vomiting and purging: the fatal effects on such an occasion are probably due to rapid absorption. (See 'Medical Gazette,' vol. 44, p. 334.) Dr. Pollock has recorded a case in which an adult was killed in ten hours by a dose of one drachm, in spite of early and violent vomiting. ('Med. Gaz.' vol. 45, p. 801.) In two cases observed by Mr. Hartley, which will be presently described, *ten grains* killed each child in a few hours. A dose of four grains, however, has been known to produce alarming symptoms. Dr. Lambert, who reports this case in Casper's 'Wochenschrift,' states that this dose gave rise to violent pain in the abdomen, vomiting, and purging. The patient then fell into strong convulsions, which lasted half an hour. He became speechless, no pulse could be perceived, the skin was cold, and it was supposed that he was dead. Stimulating frictions and poultices were employed, and he slowly recovered in about fourteen days. This poison, administered in small doses, may occasion death by reason of its exerting a depressing influence on the action of the heart. Aged persons, or those who are debilitated by disease, may die under these circumstances from a medicinal dose or doses which would produce no injury to strong and healthy adults. The effects, however, should be clearly traced to the action of the poison, and not be owing to exhaustion as a result of disease. In February 1853, a case was referred to me for examination, in which it was supposed that two doses of antimonial wine, equal to about *three grains* of tartar emetic, had caused the death of a man who was in a diseased condition, by its remote effects upon the heart. No trace of poison was found in the stomach or tissues; there were no symptoms to indicate poisoning, and under these circumstances death could not be reasonably attributed to the medicine. The man died in about twenty hours, probably from exhaustion of the vital powers as a result of disease, and not from the action of this substance.

In a case reported by Mr. Freer, of Stourbridge, a man, æt. 28, swallowed *two drachms* of tartar emetic by mistake for Epsom salts, and recovered from its effects. An hour after the poison had been taken he was found in the following state:—his pulse imperceptible; tongue dry and red; countenance cold and livid, bathed with clammy perspiration, and indicative of great suffering; violent pain in the stomach and over the whole of the abdomen, with constant spasmodic contraction of the muscles, particularly of the abdomen and arms. The fingers were firmly contracted, and the muscles quite rigid. He vomited only once, about half an hour after he had swallowed the poison, and after this, he had constant involuntary aqueous purging. An emetic of mustard and salt was given to him, and this produced violent vomiting of bilious matter.

Green tea, brandy, and decoction of oak-bark were freely given. The cramps, vomitings, and watery purging continued for six hours. The symptoms then became mitigated, and he gradually recovered, suffering chiefly from profuse night perspirations. ('Lancet,' May 22, 1847, p. 535.) This case is remarkable for the anomalous character of the symptoms, as, in the absence of active vomiting, an emetic was actually required to be given, and also for the recovery of the individual after so large a dose of the poison. In the 'Association Medical Journal,' for April 1, 1853, at p. 281, will be found reported a case in which a physician took half an ounce of tartar emetic by mistake for Rochelle salts. Vomiting did not come on for half an hour; but under good medical treatment, he recovered in a few days. I am indebted to Mr. Couling, of Brighton, a former pupil, for a case of recovery from a large dose which occurred in his practice in July 1866. A veterinary surgeon swallowed by mistake for carbonate of soda about 200 grains of tartar emetic in powder. He noticed a peculiar taste. Vomiting came on in fifteen minutes, but only after tickling his throat. This continued violently. In two hours there was severe purging, with symptoms of collapse. The vomited matters were green, and the evacuations like boiled sago. There was no appearance of blood in either. In three hours severe cramps came on, affecting all the muscles: he was unable to move or speak. Brandy and other remedies were employed, and in six hours, after a warm perspiration, he began to recover. There was suppression of urine. Only a small quantity was passed, and this was of a coffee colour. For two or three days he suffered from stiffness in the limbs and in the muscles of the abdomen. In the case which occurred to Dr. Pollock, fifty-five grains caused the death of an adult in sixteen hours. In one instance a small dose of this substance caused death by producing intestinal hæmorrhage. ('Assoc. Med. Journal,' June 10, 1853, p. 513.) Mr. Procter, of York, communicated to me, in July 1860, the cases of four children to whom, by mistake, a mixture of sulphur and tartar emetic had been given. An ounce of sublimed sulphur and one drachm of tartar emetic had been divided among the four. The symptoms presented the same characters in each; early vomiting, which became violent and incessant, pain in the bowels, purging, great thirst, cold clammy perspiration, feeble pulse, cramps of the limbs and twitchings of the muscles, with great depression. There was no sense of heat or constriction in the throat, and no difficulty of swallowing. Under treatment they all recovered.

Appearances.—The following cases, reported by Mr. Hartley, show the nature of the appearances likely to be found after death. Two children, a boy aged five years, and a girl aged three years, each swallowed a powder containing *ten grains* of tartar emetic mixed with a little sugar. It was stated that, in twenty minutes after taking the powders, they were seized with violent vomiting and purging, and great prostration of strength followed by convulsions and tetanic spasms; there was also great thirst. The boy died in eight hours, and the girl in twelve or thirteen hours after swallowing the dose. The bodies were inspected between four and five days after death. In that of the boy there was effusion of serum in the right pleura; the lower lobe of the right lung posteriorly was redder than natural, and the peritoneum was injected from recent inflammation. The mucous membrane of the duodenum was inflamed, and covered with a whitish-yellow viscid secretion; this was observed throughout the intestines, although the colour was of a deeper yellow in the large intestines: there was no ulceration. The peritoneal coat of the stomach was inflamed. The mucous membrane of this organ was also much inflamed, especially about the larger curvature and at the cardiac orifice: but there was no ulceration. The contents (about two ounces and a half of a dark bloody fluid having a slightly acid reaction) were adherent to it; and

in one case there was a patch of lymph. The tests used did not indicate the presence of antimony. With regard to other appearances, the tongue was covered with a white fur, and appeared soddened; the throat was not inflamed; the windpipe and gullet had a natural appearance. On opening the head the dura mater was found congested; the longitudinal sinus contained a coagulum of lymph and but little blood. The vessels of the surface of the brain were much injected with dark blood, the whole surface having a deep purple colour. Every portion of the brain when cut, presented many bloody points. The cerebellum and medulla oblongata were also congested; there was no effusion in the ventricles or at the base of the brain. In the body of the girl the morbid appearances were similar: there were in addition on the arms, legs, and neck, patches resembling the eruption of scarlatina. The arachnoid membrane was more opaque than usual; and on the mucous membrane of the stomach, where the inflammation was greatest, were two or three white spots, each about the size of a split pea, which appeared to be the commencement of ulceration. ('Lancet,' April 25, 1846, p. 460.) A girl, æt. 16, swallowed a dose of tartar emetic amounting to from forty to sixty grains. There was severe vomiting in a quarter of an hour, and this was soon followed by purging: these symptoms continued for about three hours. She also complained of pain, and a burning sensation down the gullet. The vomited matters were of a dark colour. On the following morning she had recovered from the severity of the symptoms; but in the afternoon there was a relapse. She continually threw her head back and screamed; the skin was warm and moist; the pupils were dilated; and the knees drawn up. She died in about thirty-six hours after taking the poison, and during the six or eight hours previous to her death she was quite delirious. An inspection was made thirty-six hours after death. The throat appeared swollen; the lungs were slightly congested; the heart was healthy, and contained about six drachms of fluid blood. The stomach contained sixteen ounces of a thick bloody fluid: at the greater extremity the coats were softened, and blood was effused under the mucous coat in several places. The small intestines contained a similar fluid, with much mucus; but there was no appearance of inflammation. Only slight traces of the poison were found in the contents of the stomach by the usual tests, the greater part having probably passed off by vomiting and purging. (Mr. Beale, in 'Lancet,' Jan. 21, 1854.) In animals poisoned by this substance, Dr. Pavy and I have found general inflammation of the lower half of the intestines.

It has been hitherto supposed that the cases in which this poison has proved fatal have been few; but I have elsewhere reported thirty-seven, of which sixteen were fatal. The smallest fatal dose was in a child, *three quarters of a grain*, and in an adult, two grains; but in this instance there were circumstances which favoured the fatal operation of the poison. ('Guy's Hospital Reports,' Oct. 1857.)

Chronic poisoning.—A good account of the effects produced by tartar emetic, given at intervals in small doses to healthy persons, has been published by Dr. Mayerhofer ('Heller's Archiv.' 1846, pts. 2, 3, 4, p. 100 *et seq.*). The principal symptoms are—great nausea, vomiting of mucous and bilious liquids, great depression, watery purging, followed often by constipation of the bowels, small, contracted, and frequent pulse, loss of voice and muscular strength, coldness of the skin, with clammy perspiration, and death from complete exhaustion. Several cases have occurred in this country, which show that tartar emetic has been thus criminally employed. In addition to the cases of *Ann Palmer* and *J. P. Cook*, there are those of *Reg.* v. *M'Mullen*, Liverpool Summer Assizes, 1856; *Reg.* v. *Freeman*, Drogheda Spring Assizes, 1857; and the cases of the *James family* at Liverpool (*Reg.* v. *Winslow*, Liverpool

Autumn Assizes, 1860). The prisoner *Winslow* was indicted for the murder of his mistress, Ann James. It was clearly proved that antimony had been administered to the deceased, not only by the careful discrimination of the symptoms made by Dr. Cameron, but by the detection of the poison in the urine during life by Dr. Edwards. The deceased was at the time labouring under malignant disease affecting the cæcum and stomach, but that her death had been accelerated by antimony there could be no doubt. The prisoner was acquitted, owing to the difficulty of proving the act of administration. The poison had been given at intervals in small doses, and as deceased survived about a fortnight after the last dose, it was found only in traces in the various organs. The death of this woman led to the exhumation of the bodies of three of her relatives who had lived in the same house with her and the prisoner, and had died suddenly some months previously under suspicious circumstances. The viscera of these bodies were examined by Dr. Edwards, Dr. Miller, and myself, and in each case antimony was found in small quantity, but still extensively diffused through the organs. There was no reason to doubt, so far as the history of their cases could be obtained, that they were victims to chronic poisoning by antimony. This was the only cause of death, but it was not suspected at the time. (See 'Guy's Hospital Reports,' October 1857, and October 1860; also *Reg.* v. *Hardman*, Lancaster Summer Assizes, 1857.)

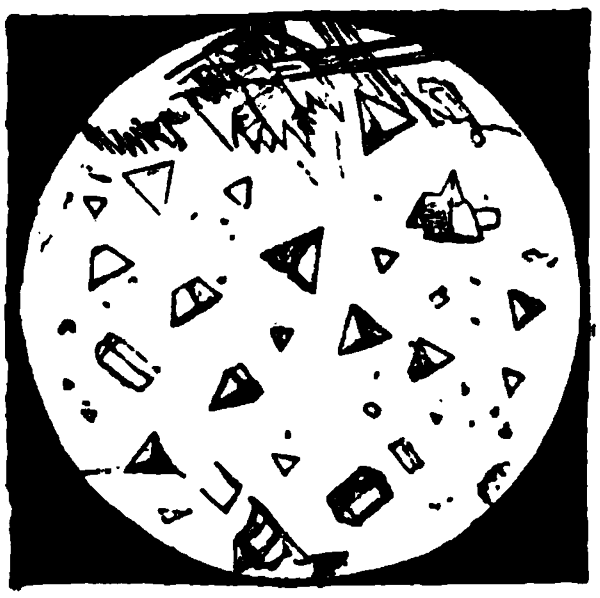
Criminal trials for poisoning with tartar emetic in the *acute* form are rare. It is a poison which cannot easily be given in a large dose without producing speedily well marked effects; and as vomiting is a common symptom, the poison is thus early ejected from the stomach. An extraordinary trial for murder by alleged poisoning with this substance took place at Annapolis, U.S., in December 1871. *Mrs. E. Wharton* was charged with poisoning her friend *General Ketchum.* The trial lasted fifty-two days, and an astonishing amount of scientific evidence was brought forward for the prosecution and defence, apparently owing to the high social position of the parties; for there is nothing, medically speaking, in the case itself that might not have been settled in forty-eight hours. The General died after a short illness, but the symptoms, taken as a whole, bore no resemblance to those observed in poisoning with antimony, and but for the alleged discovery of twenty grains of tartar emetic in the stomach after death, no suspicion of poisoning would have probably arisen. The appearances in the body proved nothing for or against antimonial poisoning, and some physicians of experience deposed that the symptoms and appearances were consistent with disease affecting the membranes of the brain and spinal marrow. (See 'Guy's Hospital Reports' for Oct. 1857, in which thirty-seven cases of poisoning by antimony are recorded.) On examining the chemical evidence, it appears that the process by sulphuretted hydrogen alone was employed, and a red-brown sulphide resembling that of antimony in chemical properties was obtained; but the quantity obtained as sulphide was only four-tenths of a grain, estimated as equivalent to *eight-tenths of a grain* of tartar emetic. Thus the chemical analysis brought out only a fraction of a grain, not amounting to one-twentieth part of the quantity said to be present; and no separation of antimony in the metallic state was made to corroborate the inference drawn from the coloured precipitate produced by sulphuretted hydrogen. No chemical results were produced in Court, although twenty grains would have allowed of the production of metallic antimony in a few minutes by copper, tin, zinc, and platinum, or by Marsh's process. The evidence that antimony was really there was not satisfactory, and that twenty grains were present in the stomach was wholly unproved. The chemical evidence does not therefore conflict with the pathological evidence, for it failed to show with clearness and distinctness the presence and proportion of the poison said

to have been found. The jury upon such weak evidence properly acquitted the prisoner ('Report of Trial of Mrs. E. G. Wharton on the Charge of Poisoning General W. S. Ketchum,' Dec. 1871, Jan. 1872 'Baltimore Gazette;' 'American Jour. Med. Sci.' April 1872, p. 329.)

Chemical Analysis. Tartar Emetic as a solid.—In the state of powder it is white and crystalline. It has been occasionally sold by mistake for tartaric acid with soda powders, and sometimes for cream of tartar.—1. It is easily dissolved by water—it is taken up by fourteen parts of cold, and two of boiling water; the solution has a faint acid reaction, and an acrid metallic taste; it is decomposed by long keeping. It is insoluble in alcohol. 2. The powder dropped into sulphide of ammonium is turned of a deep reddish-brown colour, and is thereby known from other poisonous metallic salts. 3. When heated in a reduction-tube, it is charred, but does not melt before charring, like the acetate of lead. The metal is partially reduced by the carbon of the vegetable acid, and the decomposed mass has a greyish-blue metallic lustre. I have not found that a metallic sublimate is produced in this experiment by the heat of a spirit-lamp. 4. When boiled in water containing one-sixth part of pure hydrochloric acid, and metallic copper is immersed in the boiling liquid, a grey deposit of antimony takes place on this metal. The colour of the deposit is violet-red if the quantity is very small, but the deposit is black and pulverulent if very large. 5. The solution acidulated with one tenth part of hydrochloric acid gives in the cold a black deposit of antimony on a surface of pure tin. A slip of pure tin-foil may be used in this experiment. A solution of arsenic produces no deposit on tin under these circumstances. A better method of distinguishing antimony from arsenic or of detecting antimony when mixed with arsenic, is to employ the chloride of tin with fuming hydrochloric acid in equal parts. Both acids of arsenic and all their solid compounds are immediately precipitated on boiling them in this mixture, as brown metallic arsenic. Pure tartar emetic in powder produces no change of colour or precipitate, unless it contains some traces of arsenic, when the liquid will become brownish-coloured.

Tartar Emetic in solution.—1. On slowly evaporating a small quantity on a slip of glass, it will crystallize in *tetrahedra* and in other derivatives of the octahedron. If obtained from a very diluted solution, this crystallization is confused, and resembles that of arsenic. 2. *Diluted nitric acid* added to the solution, throws down a white precipitate (sub-nitrate of antimony); the other two mineral acids act in the same way; but, as they precipitate numerous other metallic solutions, there are objections to them which do not hold with respect to nitric acid. The white precipitate thus formed possesses the remarkable property of being easily and entirely dissolved by a solution of tartaric acid: it is also soluble in a large excess of nitric acid, so that if much of the test be added at once, no precipitate is produced. 3. *Ferrocyanide of potassium* does not precipitate the solution, whereby tartarized antimony is known from most other metallic poisons. 4. *Sulphide of ammonium*, or *sulphuretted hydrogen gas*, produces in the solution a reddish orange-coloured precipitate, differing in colour from every other metallic sulphide. The dry precipitate is not soluble in ammonia, but is dissolved by strong hydrochloric acid. The only test available when the quantity of antimony present in solution is small, is sulphuretted hydrogen gas.

Fig. 38.



Crystals of Tartar Emetic, magnified 30 diameters.

The foregoing tests, it will be observed, merely indicate the presence of oxide of antimony, but this is in reality the poison which we have to seek—the cream of tartar with which it is combined being merely the vehicle; and in a case of poisoning, this is no more the object of medico-legal research than if it were the vehicle for the administration of arsenic or corrosive sublimate. It is, besides, well known that tartarized antimony is the only salt of the oxide of antimony in a soluble form which is likely to be met with in medicine or chemistry. Should it be required to prove the presence of cream of tartar, this may be done by filtering the liquid from which the oxide of antimony has been entirely precipitated by sulphuretted hydrogen gas. On evaporating this liquid, the cream of tartar may be obtained.

In liquids containing organic matter.—Tartar emetic is precipitated by tannic acid in all its forms, but not readily by albumen or mucous fluids: therefore it may be found partly dissolved in the liquids of the stomach, provided no antidote has been administered. As a trial test, if the liquid is much coloured a portion of it may, like arsenic, be submitted to dialysis in a tube (p. 215); tartar emetic may be thus obtained in water in a pure state for testing. The organic liquid should be filtered, and then strongly acidulated with tartaric acid. A current of sulphuretted hydrogen gas is now passed into it, until there is no further precipitation. The sulphide is collected, washed, and dried. If it is the sulphide of antimony, it will have an orange-red or brown colour, it will be insoluble in a solution of ammonia, and when dried will be dissolved by a small quantity of boiling hydrochloric acid (forming chloride of antimony) with the evolution of sulphuretted hydrogen gas. The boiling should be continued for several minutes or until the liquid is colourless. On adding this solution, if not too acid, to water, a white precipitate of oxychloride of antimony (powder of Algaroth or Algarotti, *Mercurius Vitæ*) falls down. This is characteristic of antimony. A portion of the acid liquid may be introduced with pure zinc and sulphuric acid into a Marsh's tube or apparatus, like that described at p. 265. The gas which escapes at the jet produces a deep black deposit on paper impregnated with a solution of nitrate of silver; but unless sulphur is present it produces no change on paper impregnated with a salt of lead. When ignited, it burns with a pale yellowish-white flame, producing white fumes of teroxide of antimony. Porcelain, or glass, depressed on the flame, receives a black deposit of reduced metallic antimony, with greyish-coloured layers of oxide at the circumference. There is no metallic lustre, such as is produced by arsenic, under similar circumstances, but on examining the reverse side of the glass, a dim metallic lustre will be perceptible. This deposit, unlike arsenic, is not dissolved by a solution of chloride of lime. If a current of the gas is heated to redness while passing through the tube, a tin-white ring of metallic antimony will be deposited close to the heated spot. This is much more fixed than the deposit of arsenic, and cannot, like it, be resolved into a white sublimate of octahedral crystals. If the gas is made to pass through a small quantity of fuming nitric acid containing nitrous acid, it is decomposed, the antimony is peroxidized, and may be obtained as a white, insoluble residue on evaporation. A solution of nitrate of silver produces no change of colour in this deposit; but if one or two drops of ammonia are added, there is a black precipitate of antimonide of silver.

The following method of detecting antimony, when dissolved in any organic liquid, is based upon the principle by which copper and other metals may be detected under similar circumstances (p. 305). Acidulate a portion of the suspected liquid with hydrochloric acid, and place it in a shallow platinum capsule. Touch the platinum, through the acid liquid, with a piece of pure zinc-foil. Hydrogen is evolved, and wherever the metals come in contact, metallic antimony, in the state of a black powder, is deposited on the surface of the

platinum. The liquid should be poured off, and the capsule thoroughly washed with distilled water. This may be effected without disturbing the deposit. A small quantity of sulphide of ammonium poured on the black deposit, speedily dissolves it (if antimony) by the aid of heat, and on evaporation, an orange-red sulphide of antimony remains. This may be dissolved by a few drops of strong hydrochloric acid, and on adding the acid liquid to water, hydrated oxychloride of antimony is precipitated. By this process antimony in small quantity may be detected in any liquid containing organic matter. In place of sulphide of ammonium, strong nitric acid may be employed to oxidize the metallic deposit and the dry residue treated as described below.

In the tissues.—The antimony may be in so small a quantity, as it is deposited in the organs, that neither the sulphuretted hydrogen nor the galvanic process will yield any satisfactory results. The liver or other organ should be finely cut up and boiled in a mixture of one part of hydrochloric acid and five parts of water. After some time, the liquid may be tested by introducing into it a slip of polished copper-foil free from antimony. If antimony is present in small quantity, the copper will acquire a reddish or violet-coloured deposit on its surface: if in large quantity, the deposit will be grey with a metallic lustre, or sometimes in the state of a black powder. These deposits do not yield octahedral crystals like those obtained from arsenic. A slip of pure tin-foil may be suspended in the cold, in another portion of the acid liquid, diluted so that the hydrochloric acid forms only one-tenth part by measure. Either immediately, or in the course of a few hours, if antimony is present, the tin is covered with a black deposit of metallic antimony. As arsenic is not deposited on pure tin under similar circumstances, this furnishes a ready method of detecting the admixture of antimony with arsenic. These may be regarded as trial tests. For the demonstration of the presence of antimony, when in mere traces, we may resort to the following process, by which antimony may be completely separated from organic substances. Coil a portion of pure zinc-foil round a portion of clean platinum-foil, and introduce the two metals into the hydrochloric-acid decoction of the tissues, just sufficiently diluted to prevent too violent an action on the zinc. (See fig. 28, p. 285.) Warm the organic liquid, and suspend the coils in it. Sooner or later, according to the quantity of antimony present, the platinum will be coated with an adhering black powder of metallic antimony. Wash the platinum-foil, and digest it in strong nitric acid. So soon as the black deposit of antimony is dissolved from its surface, the platinum may be removed. Add a few drops of nitric acid, and evaporate the acid liquid to dryness. The residue, redissolved in hydrochloric acid, and the solution diluted and treated with a current of sulphuretted hydrogen, will yield an orange-red sulphide of antimony. This black deposit of antimony is also readily dissolved from platinum-foil by sulphide of ammonium, yielding on evaporation an orange-red sulphide of antimony; it is soluble in nitric, but not in hydrochloric acid. When kept for a few days in contact with water and air, the black metallic deposit is sometimes converted into white oxide of antimony, and entirely disappears. Antimony in the metallic state is so easily procured from a small quantity of material, by one or other of the above-mentioned processes, that on no account should this be omitted. The procuring of the metal may be made subsidiary to the procuring of the sulphide, as the metal can be easily oxidized and converted into sulphide in a pure form, and obtained entirely free from organic matter. A reliance on a small quantity of a coloured precipitate from sulphuretted hydrogen alone, would be most unsatisfactory as chemical evidence.

A medical jurist must remember that the discovery of tartar emetic in the contents of a stomach is by no means a proof of its having been taken or administered as a poison; since it is frequently prescribed as a medicine, and often

taken as such by persons of their own accord. We could only suspect that it existed as a poison or had caused death, when the quantity present was large, and there were corresponding appearances of irritation in the stomach and bowels. The presence of any quantity, if not lawfully administered as a medicine, is always a suspicious fact and demands explanation. In two cases of criminal administration in small doses, the quantity found in each body did not exceed three grains. The mere discovery of it in a medicinal mixture cannot of itself be evidence of an intent to poison.

The detection of antimony in the tissues does not necessarily indicate that it has been criminally administered or has caused death; but its presence should be reasonably accounted for, as antimony may have been unlawfully administered. In several cases of suspected death from poison, deposits on copper, evidently of an antimonial nature, have been obtained from the liver or tissues. On inquiry it has been found that antimonial medicines had been taken shortly before death. Conversely, when no antimony is found, or the metal is present in the tissues in minute quantity, it is still consistent with medical experience and observation that the person may have died from antimony. The case of *Mrs. Peters*, of Yeovil (July 1860), furnishes a remarkable illustration of this fact. This lady had symptoms during her illness which were referred by her medical attendants to the effects of small doses of antimony. Antimony was found in the urine both by them as well as by Mr. Herapath: but after death (*i.e.* in about nine days) no antimony was found in the tissues or any part of the body. Upon this fact and the evidence of coexisting disease, it was alleged that she had died from disease and not from poison. The jury returned a verdict to the effect that her death had been accelerated by irritant poison. ('Med. Times and Gazette,' Aug. 25, 1860, p. 190; Sept. 15, p. 271; and Sept 29, p. 317.) Assuming the results of the analysis of the urine during life to be correct, there can be no question that antimony was administered to her; and the statement of the acceleration of death is rendered probable. The case is important in this respect; it shows that antimony may be found in an evacuation and that death may be accelerated by it; but although the person may die within nine days, none may be detected in the body.

CHLORIDE OR BUTTER OF ANTIMONY.—*Symptoms and Appearances.*—A boy, æt. 12, swallowed by mistake for ginger-beer four or five drachms of a solution of butter of antimony. In half an hour he was seized with vomiting, which continued at intervals for two hours. There was faintness, with general weakness, and great prostration of strength. Remedial means were adopted, and the next day the chief symptoms were heat and uneasiness in the mouth and throat, with pain in swallowing. There were numerous abrasions on the mucous membrane of the mouth and throat; and there was slight fever, from which the boy quite recovered in about eight days. Another case of recovery from a dose of an ounce is reported in the 'Lancet,' Feb. 26, 1848, p. 230. I am indebted for the following case to Mr. Mann. An army surgeon swallowed, for the purpose of suicide, from two to three ounces by measure of chloride of antimony. About an hour afterwards he was seen by Mr. Mann. There was entire prostration of strength, with coldness of skin, and incessant attempts to vomit. The most excruciating griping pains were felt in the abdomen; and there was a frequent desire to evacuate the bowels, but nothing was passed. In the course of a few hours reaction took place, the pain subsided, and the pulse rose to 120. There was now a strong disposition to sleep, so that he appeared as if labouring under the effects of a narcotic poison. In this state he continued until he died, ten hours and a half after he had swallowed the poison. On inspection the interior of the alimentary canal, from the mouth downwards to the jejunum, presented a black appearance, as if the parts had been charred.

In general, there was no mucous membrane remaining, either on the stomach or elsewhere; only a flocculent substance, which could be easily scraped off with the back of the scalpel, leaving the submucous tissue and the peritoneal coat. All these parts were so soft that they were easily torn by the fingers. Mr. Evans, of Northampton, has given me in detail a case which occurred to him in May 1868. A man swallowed three or four ounces of bronzing liquid, which proved to be a solution of chloride of antimony. He vomited violently, but continued his work for an hour; the vomited matters were of a yellowish-green colour. There was pain in the stomach, but no purging. He was not seen by a medical man. He had passed a sleepless night, and complained much of oppression in the region of the heart. He died in about eighteen hours. On inspection the mucous membrane of the stomach was found much corroded. Near the intestinal end there were numerous putty-like masses. In parts it was of a vividly red colour, and in other parts blackened. There was no perforation. The duodenum presented similar appearances. There was no mark of corrosion on the lips, or in the lower part of the gullet. The upper part of this tube, the fauces and mouth, could not be examined. Antimony was found in the putty-like masses of membrane as well as in the contents of the stomach and the liquid swallowed.

Analysis.—1. If any portion of the chloride is left in the vessel, it may be tested by adding a few drops to a large quantity of water, when the whitish-yellow oxychloride of antimony will be precipitated: the supernatant liquid will contain hydrochloric acid, which may be detected by nitrate of silver. 2. The precipitated white oxychloride is dissolved by a solution of tartaric acid. 3. This acid solution is precipitated of an orange-red colour by a current of sulphuretted hydrogen gas.

In the tissues.—Any antimonial compound may be dissolved out of the coats of the stomach or other structures, by boiling them in tartaric or hydrochloric acid. The hydrochloric solution when cold may be diluted with nine parts by measure of water, and a slip of pure tin-foil suspended in the liquid. A black deposit on the tin, after sufficient contact, indicates the presence of antimony. The metal may be also separated by platinum and zinc, according to the method described at p. 313, or it may be precipitated by sulphuretted hydrogen.

Preparations of Zinc.

White Vitriol. *Sulphate of Zinc. Symptoms and Appearances.*—The symptoms produced by an over-dose of sulphate of zinc are pain in the abdomen and violent vomiting, coming on almost immediately, followed by severe purging. After death the stomach and intestines have been found inflamed. The sulphate appears to act as a pure irritant; it has no corrosive properties. This salt may cause death indirectly as the result of exhaustion from violent vomiting, when an ordinary dose has been given to a person already debilitated by disease. ('Med. Times and Gaz.' July 16, 1853, p. 78.) A case is reported by Dr. Ogle, in which it is supposed that the sulphate destroyed life by its slow or chronic effects. ('Lancet,' Aug. 27, 1859, p. 210.) Neither the sulphate nor the oxide of zinc can be regarded as powerful irritants, although they are usually described as poisons. MM. Tardieu and Roussin have published a case of criminal poisoning by sulphate of zinc administered in soup. A woman, æt 60, died in three days under the usual symptoms of irritant poisoning (gastro-enteritis). Zinc was detected in the coats of the stomach and intestines, as well as in the spleen and liver ('Ann. d'Hyg.' 1871, 2, 341.) In one case a lady recovered after taking sixty-seven grains ('Lancet,' May 17, 1856). In another, which occurred in May, 1872, communicated to me by Dr. Mackintosh, of Downing, a man, æt. 20, recovered in a few days after taking an ounce of sulphate of zinc by mistake for Epsom salts. There was early

vomiting and purging of a most violent kind, with great prostration of strength. The greater part of this large dose was no doubt thus carried out of the body.

In cases of epilepsy, the late Dr. Babington gave sulphate of zinc in doses of two scruples, three times a day, having first commenced with small doses. No ill effects followed, and none of the usual symptoms of irritation were observed. This may have been owing to a tolerance of the medicine. With respect to the *oxide of zinc*, Dr. Marcet states that he has prescribed it in large doses without injury to health. One patient, an epileptic, took as much as one pound in seven months, the largest quantity taken in one day being seventy grains. Although he did not suffer from the remedy, the disease was not cured. ('Lancet,' March 1, 1862, p. 224.)

Analysis.—The pure sulphate is seen in white prismatic crystals, closely resembling in appearance sulphate of magnesia and oxalic acid; from oxalic acid it is distinguished by remaining fixed when heated on platinum-foil; from the sulphate of magnesia, by tests applied to its solution. It is readily dissolved by water, this fluid taking up about one-third of its weight at common temperatures. Tests for the *solution.*—The solution has a slightly acid reaction. The following tests may be used for the detection of oxide of zinc. 1. *Ammonia* gives a white precipitate, very soluble in an excess of the alkali. 2. *Carbonate of ammonia*, a white precipitate, soluble in a large excess of the test. 3. *Ferrocyanide of potassium*, a white precipitate. 4. *Sulphuretted hydrogen* and sulphide of ammonium, a milky-white precipitate, provided the solution is *pure* and neutral, or nearly so. If the solution is very acid, sulphuretted hydrogen produces no effect whatever. 5. Zinc may be separated in the metallic state by placing in the solution a slip of magnesium.

In Organic liquids.—If the sulphate of zinc is dissolved and the solution is not too acid, we may pass into it a current of sulphuretted hydrogen gas; the presence of zinc is immediately indicated by a milky-white froth and precipitate; the sulphide may be collected and decomposed by boiling it with hydrochloric acid. The solution may be then tested for zinc. This compound being frequently employed as an emetic, may be innocently present in an organic liquid, or in the contents of the stomach. Sulphate of zinc is occasionally a fraudulent addition to bread. (Horn's 'Vierteljahrsschrift,' 1870, 1, 323.)

Chloride of Zinc.—The chloride of zinc is sold to the public as a disinfectant, under the name of 'Sir W. Burnett's Fluid.' This is a highly concentrated solution of the pure, or sometimes impure, chloride of the metal; it has been taken by accident in several cases, and in one instance was supposed to have been criminally administered as a poison. Eight deaths from chloride of zinc are reported to have occurred in four years (1863–7).

Symptoms.—In a case reported by Dr. Stratton, about two ounces of a solution containing only twelve grains of the chloride were swallowed. The patient immediately felt pain and nausea; vomiting followed, and she recovered, but suffered from some indisposition for three weeks. In a second case, a wineglassful, equivalent to at least 200 grains of solid chloride, was swallowed. The man instantly experienced a burning pain in the gullet, burning and griping pain in the stomach, great nausea, and coldness. Vomiting came on in two minutes; the legs were drawn up to the body; there was cold perspiration, with other signs of collapse. The man perfectly recovered in sixteen days. ('Ed. Med. and Surg. Journal,' Oct. 1848, p. 335; and 'British American Journal,' Dec. 1848, p. 201.) Other cases show that the concentrated liquid has a strong corrosive action, destroying the membrane of the mouth, throat, gullet, and stomach. There has been frothing of the mouth, with general lividity, and coldness of the skin. In a case in which only a mouthful of the fluid had been swallowed, the patient experienced giddiness and loss of sight,

with immediate burning heat in the stomach: vomiting and purging came on, and the former symptom continued for a week. There was so much irritability of the stomach for a period of three weeks, that the patient became greatly reduced. Among the early symptoms was loss of voice, which did not return for five weeks. ('Med. Times,' Oct. 11, 1851, p. 382; and Nov. 8, 1851, p. 497.) Dr. R. Hassall met with a case in which the nervous symptoms were strongly marked, and were of a peculiar kind. Three ounces of 'Burnett's Fluid' were swallowed. There was immediately a sense of constriction in the throat, with a hot burning sensation in the stomach. There was no pain in the mouth, and there was no appearance of corrosion in this cavity or on the lips. There was incessant vomiting, the vomited matters consisting of thick mucus streaked with blood; and some portions of mucous membrane were discharged. There was no purging until the third day, when the discharges from the bowels had a coffee-ground appearance. After the lapse of a fortnight, a train of nervous symptoms set in, indicated by a complete perversion of taste and smell. The patient recovered in about three months. ('Lancet,' Aug. 20, 1853, p. 159.) A case which occurred to Dr. Markham proved fatal in about *ten weeks* after the poison had been swallowed. The patient, a woman, æt. 46, took half a wine-glassful of 'Burnett's Fluid,' equal to about 100 grains of chloride of zinc. Immediately after taking it, she suffered from vomiting and pain in the stomach. She drank freely of water: the vomiting ceased in a few days, and she appeared to have recovered. In about three weeks the vomiting returned: it was incessant, and with this there was pain in the stomach. She sank exhausted, evidently from the secondary effects of the poison. ('Medical Times and Gazette,' June 11, 1859, p. 595.)

Appearances after death.—In the case of an infant, aged fifteen months, who died from the effects of this poison, the lining membrane of the mouth and throat was white and opaque. The stomach was hard and leathery, containing a liquid like curds and whey. Its inner surface was corrugated, opaque, and tinged of a dark leathern hue. The lungs and kidneys were congested. The fluid of the stomach was found to contain chloride of zinc. ('Med. Times,' July 13, 1850, p. 47.) These facts show that the concentrated solution of chloride of zinc is both a corrosive and an irritant poison, exerting also occasionally an action on the nervous system. In a case which proved fatal at Guy's Hospital, in 1856, the coats of the stomach were excessively thickened, and had a leathery consistency. In another case, the stomach is described as being shrivelled up and ulcerated. ('Pharm. Jour.' Jan. 1867, p. 420.) In Dr. Markham's case, the stomach was so constricted at the intestinal end by a cicatrix, that it would only admit a crow-quill. The pyloric opening was involved in this cicatrix, which was about one quarter of an inch wide. There was no other sign of disease in the body. This case proves that death may occur from the poison even after apparent recovery. The chloride of zinc may destroy life either by producing stricture of the gullet or pylorus, or by its chemical action on the lining membrane of the stomach leading to a loss of power of digestion, emaciation and exhaustion. In 1863 several deaths were reported to have taken place in consequence of 'Burnett's Fluid' having been mistaken for medicine. In one of these a lady swallowed a wine-glassful in place of fluid magnesia. She suffered severely, and died from the secondary consequences of the poison, after six weeks. In another, a girl, æt. 17, swallowed half a wine-glassful of the fluid, and died from the effects in less than two hours. The symptoms here were copious vomiting of frothy mucus with shreds of membrane, and cramps in the legs, which were drawn up to the abdomen. (Other cases, in which the symptoms and appearances were somewhat similar, will be found reported in the 'Lancet,' 1864, 1, 35; and Sept. 3, 1864, p. 267.)

Analysis.—The chlorine may be detected by nitrate of silver—the zinc by the tests above described. (See Sulphate.) If a portion of the solution diluted is placed in a platinum capsule, and the platinum touched with magnesium, the zinc is immediately obtained in the metallic state.

Zinc can be detected in the *tissues* only by incineration and an examination of the ash. The chloride is, however, sometimes used for the preservation of the dead body. This might account for its occasional presence.

Preparations of Tin.

The only preparations of this metal which require to be noticed as poisons are the *Chlorides*, or *Muriates*, a mixture of which is extensively used in the arts, under the name of *Dyer's Spirit*. The salts may exist in the form of whitish-yellow crystals; but more commonly they are met with in a strongly acid solution in water. They are irritant poisons; but so seldom used as such, that only one death occurred from them in England and Wales during a period of two years.

Preparations of Silver.

Nitrate of Silver. Lunar Caustic. Lapis Infernalis.—This substance, which is commonly met with in small sticks of a white or dark-grey colour, is readily soluble in distilled water; in common water it forms a milky solution. It acts as a powerful corrosive, destroying all the organic tissues with which it comes in contact. There are at least two cases on record in which it has proved fatal in the human subject: one of these occurred in 1837–8, but the particulars are unknown. The symptoms come on immediately, and the whitish-flaky matter vomited is rendered dark by exposure to light. Dark-coloured spots on the exposed parts of the skin will also indicate the nature of the poison. In September 1861, a woman, æt. 51, died in three days from the effects of taking a six-ounce mixture containing fifty grains of nitrate of silver (lunar caustic) given in divided doses. She vomited a brownish-yellow fluid before death. The stomach and intestines were found inflamed. It is stated that silver was found in the substance of the stomach and liver. A well-marked case of poisoning with this substance occurred to Mr. Scattergood. A portion of a stick of lunar caustic dropped down the throat of a child aged fifteen months. In spite of treatment, the child died in six hours, in violent convulsions. ('British Med. Jour.' May 1871, and 'Amer. Jour. Med. Sci.' July 1871, p. 287.)

Preparations of Gold.

Perchloride.—This is the only preparation of gold which requires notice. It is a powerful irritant poison, acting locally like the nitrate of silver. Nothing is known of its poisonous effects on man; but, in administering it to animals, Orfila found that it caused extensive inflammation, and even ulceration, of the mucous membrane of the stomach. ('Toxicologie,' vol. 2, p. 30.) The metal is absorbed and carried into the tissues, but its poisonous action appears to be wholly independent of absorption.

Preparations of Iron.

Sulphate of Iron. Copperas. Green Vitriol.—This compound has been several times administered with malicious intention. One death from it took place in 1837–8, and another of recent date (1869) was the subject of a criminal trial in France. A man was convicted of having killed his wife and his son by administering to them sulphate of iron in coffee. (Bouchardat, 'Ann. de Thérapeutique,' 1872, p. 146.) It is not, however, an active preparation; for a girl who swallowed an ounce of it recovered, although she suffered for some

hours from violent pain, vomiting, and purging. ('Christison on Poisons,' p. 506.) Green vitriol or copperas is sometimes given as an abortive. A suspicious case is reported, in which a woman far advanced in pregnancy, but enjoying good health, was suddenly seized at midnight with vomiting and purging and died in about fourteen hours. The body, which had been buried, was disinterred, and iron found in large quantities in the viscera. The symptoms are not always of this violent kind. In a case which occurred to M. Chevallier, a man gave a large dose of sulphate of iron to his wife. There was neither colic nor vomiting. The woman lost her appetite, but ultimately recovered. In another case reported by the same authority, a woman was tried and convicted of poisoning her husband with sulphate of iron; but in consequence of the great diversity of opinion among the scientific witnesses at the trial respecting the poisonous properties of this metallic salt, and the dose in which it would be likely to operate injuriously, the Court and jury recommended that the sentence of death should not be carried into execution. ('Ann. d'Hyg.' 1851, 1, 155; 'Med. Gazette,' 1850, 45, 640.) The reader will find some remarks in reference to the action of the sulphate of iron on the body, by the late M. Orfila, in the same journal, 1851, 2, 337. At the Nottingham Autumn Assizes, 1859, a woman of the name of *Riley* was indicted for administering copperas to two children. She put the substance into gruel. It gave to the gruel a greenish colour and a peculiar taste, which led to the discovery. It caused sickness, but no other serious symptoms. As there was no evidence of an intent to murder, and it was then not unlawful to administer poison with any other intent, the prisoner was acquitted. This salt has been much used for criminal purposes in France. (See 'Medical Gazette,' vol. 47, p. 307; also 'Ann. d'Hyg.' 1850, 1, 180, 416; and 1851, 1, 155; 2, 337.) Sulphate of iron is said to have proved fatal to sheep. It had been mixed with the pulp of beet-root for cattle-food. ('Med. Times and Gazette,' 1863, 1, 511.)

Muriate of Iron. Tincture of Perchloride of Iron.—This is an acid solution of perchloride of iron in rectified spirit: it is of a red-brown colour, and is much used in medicine. It is sometimes made with wood-spirit or methylated spirit, which gives to it a peculiar odour. Dr. Christison relates an instance in which a man by mistake swallowed an ounce and a half of this liquid: the symptoms were somewhat like those produced by hydrochloric acid. He at first rallied, but died in about five weeks. The stomach was found partially inflamed and thickened towards the intestinal end. A case was reported to the Westminster Medical Society, in November 1842, in which a girl, æt. 15, five months advanced in pregnancy, swallowed an ounce of the tincture of muriate of iron in four doses in one day, for the purpose of inducing abortion. Great irritation of the whole urinary system followed; but this was speedily removed, and she recovered. In another case, reported by Mr. Aymot, a healthy married woman swallowed, by mistake for an aperient draught, *one ounce and a half* of the tincture of muriate of iron. She immediately ejected a portion, and violent retching came on, which continued for some time. There was great swelling of the glottis, with cough, and difficulty of swallowing. These symptoms were followed by heat and dryness of the throat, with a pricking sensation along the course of the gullet and stomach; and in the afternoon a quantity of dark liquid blood was vomited. The motions were black, owing doubtless to the action of sulphur upon the metal. In about a month the patient was perfectly restored to health. ('Provincial Journal,' April 7 and 21, 1847, p. 180.) Another case of recovery from a large dose has been reported by Sir James Murray. The patient, æt. 72, swallowed by mistake *three ounces* of the tincture in a concentrated state. The tongue soon became swollen; a ropy mucus flowed from the mouth and nose; there was croupy respiration, with a sense of impending suffocation. The pulse was feeble, the

skin cold and clammy, and the face swollen and livid. A castor-oil mixture brought away inky evacuations, and the patient rapidly recovered. ('Dub. Med. Press,' Feb. 21, 1849.) From the occurrence of these cases of recovery, it would be a mistake to infer that this is not a noxious compound. The largeness of the dose has commonly led to early vomiting, and the rejection of the greater part of the acid liquid. Besides, it varies much in strength, and unless this is defined in any given case, it is difficult to draw an inference of the actual quantity taken.

Comparatively small doses may seriously affect pregnant females, and among the criminal uses to which this preparation is put may be mentioned that of procuring abortion. At the Lincoln Lent Assizes, 1863 (*Reg.* v. *Rumble*), a druggist was convicted of having supplied this noxious liquid to a woman with the intent to procure her miscarriage. He directed her to take a teaspoonful three times a day, and at the same time prescribed for her eight pills a day, each containing half a grain of powdered cantharides. Although the woman had taken only two doses of the tincture of perchloride of iron, she suffered from severe pain over the whole of the abdomen, with violent pain in the region of the stomach and bladder: there was constant vomiting of a greenish-coloured matter, and great pain in passing her urine. The quantity of urine secreted was small, and contained much blood. These symptoms were in great part due to the cantharides. The proper dose of the iron-tincture is from ten to forty minims. Here it had been greatly exceeded, without any lawful excuse on the part of the prescriber. A case of recovery from an ounce of this tincture is quoted in the 'Pharmaceutical Journal' (April 1869, p. 605). A woman, æt. 30, swallowed this quantity. She suffered from vomiting and purging, the motions being black. Emetics were given, and she recovered in five hours. ('Lancet,' January 2, 1869, p. 9.)

The perchloride of iron has been used as an injection in uterine diseases; but it is a most powerful local irritant, and in one instance caused death by inducing peritonitis. The symptoms were rigors, severe vomiting, and abdominal pain. The mucous membrane of the uterus was stained of a deep black, and iron was readily detected in its substance. ('Amer. Jour. Med. Sci.' April 1870, p. 566.)

Chemical Analysis.—The hydrochloric acid may be detected by nitrate of silver and nitric acid, while the peroxide of iron is immediately indicated by a precipitate of Prussian blue on adding a solution of *Ferrocyanide of potassium.* The quantity present may be determined by evaporation.

PREPARATIONS OF BISMUTH.

Subnitrate of Bismuth. Pearl-White. Magistery of Bismuth.—This sub-
ce, in a dose of *two drachms*, caused the death of an adult in nine days.
ere was a strong metallic taste in the mouth, burning pain in the throat,
h vomiting and purging, coldness of the surface, and spasms of the arms
l legs. On inspection, the throat, windpipe, and gullet were found in-
ned; and there was inflammatory redness in the stomach and throughout
intestinal canal. ('Sobernheim,' p. 335.) In a case mentioned by Dr.
ill, a man took by mistake *six drachms* of the subnitrate in divided doses
three days. He suffered from vomiting and pain in the abdomen and
oat, but finally recovered. ('Outlines,' p. 115.) These cases are sufficient
prove that a substance which is but slightly soluble in water may exert a
erfully poisonous action. The oxide and subnitrate of bismuth, owing to
erfect washing, are frequently contaminated with arsenic in the form of
nic acid.

he symptoms produced by large doses have closely resembled those caused
arsenic, and as the medicinal subnitrate generally contains arsenic, the

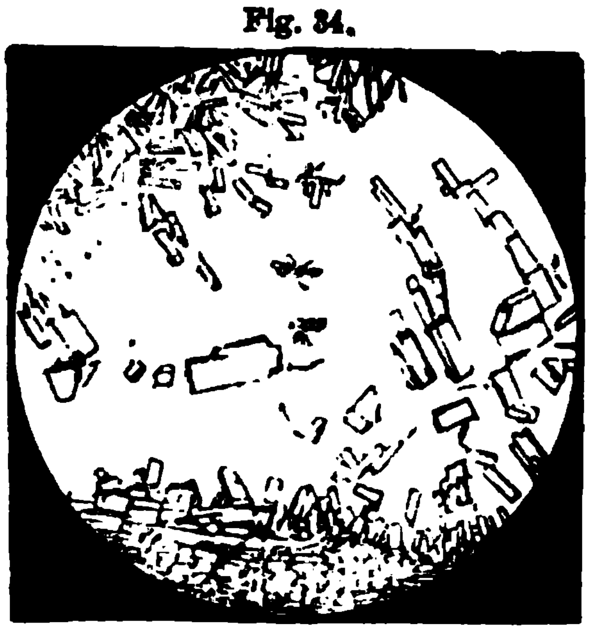
symptoms may have been on some occasions due to this impurity. I found arsenic in comparatively large proportion, in samples obtained from three respectable retail druggists. Only two specimens out of five were found free from this poison. The arsenic may be detected by dissolving the subnitrate in pure hydrochloric acid slightly diluted, and introducing it into Marsh's apparatus. The arsenical flame is apparent on combustion, and the usual deposits may be obtained on glass and porcelain. The products of combustion may be collected and tested by the processes described at p. 265. This impurity in the subnitrate may modify a conclusion respecting the presence of traces of arsenic in a body when bismuth has been administered medicinally. (See 'Brit. and For. Med. Chir. Rev.' Oct. 1858.)

Analysis.—The subnitrate is a whitish chalky-looking uncrystalline powder insoluble in water, dissolved by hydrochloric acid, and again precipitated white by dilution with water: the white precipitate is insoluble in tartaric acid, and is blackened by a solution of sulphuretted hydrogen, or by sulphide of ammonium. A solution of the substance in nitric acid gives no precipitate with diluted sulphuric acid.

Preparations of Chromium.

Bichromate of Potash.—Well-observed instances of poisoning by this compound, which is now extensively used in the arts, are rare; and therefore the details of the following case, communicated to the 'Medical Gazette' (vol. 33, p. 734) by Mr. Wilson of Leeds, are of practical interest. A man, æt. 64, was found dead in his bed twelve hours after he had gone to rest: he had been heard to snore loudly during the night, but this had occasioned no alarm to his relatives. When discovered he was lying on his left side, his lower limbs being a little drawn up to his body: his countenance was pale, placid, and composed; eyes and mouth closed; pupils dilated; no discharge from any of the outlets of the body; no marks of vomiting or purging, nor any stain upon his hands or person, or upon the bed-linen or furniture. The surface was moderately warm. Some dye-stuff, in the form of a black powder, was found in his pocket. On inspection, the brain and its membranes were healthy and natural; there was neither congestion nor effusion in any part. The thoracic viscera were equally healthy, as well as those of the abdomen, with the exception of the liver, which contained several hydatids. A pint of a turbid inky-looking fluid was found in the stomach. The mucous membrane was red and vascular, particularly at the union of the greater end with the gullet: this was ascribed to the known intemperate habits of the deceased. In the absence of any obvious cause for death, poison was suspected; and on analyzing the contents of the stomach they were found to contain bichromate of potash. The dye-powder taken from the man's pocket consisted of this salt mixed with cream of tartar and sand. It is remarkable that in this case there was neither vomiting nor purging. The salt does not appear to have operated so much by its irritant properties, as by its indirect effects on the nervous system. This, however, is by no means an unusual occurrence, even with irritants far more powerful than the bichromate of potash. A case has been communicated to me by Mr. Bishop, of Kirkstall, in which a boy recovered from the effects of a dose of this salt, but only after the lapse of four months. The first symptoms were pain, vomiting, dilated and fixed pupils, cramps in the

Fig. 34.



Crystals of Bichromate of Potash, magnified 30 diameters. They have a deep orange-red colour.

legs, and insensibility. His recovery was due to early and active treatment. (A report of this case will be found in 'Guy's Hosp. Reports,' Oct. 1850, p. 216.) Another case in which, owing to timely and proper treatment, a man, æt. 37, recovered from a large dose of the salt, has been communicated to me by Dr. H. C. Andrews (July 1859). It seems that with suicidal intent the man swallowed about two ounces of the bichromate in solution, mixed with pearlash. In about two hours he was seen by Dr. Andrews and he was then apparently in a dying state. He was suffering chiefly from severe cramps, the pupils were dilated, the pulse was scarcely perceptible, and there was vomiting and purging of greenish-coloured evacuations. The stomach-pump was used, and olive-oil and diluents were given. In about nine hours the urgent symptoms abated, and the man complained only of great pain in the shoulders and legs. There was no gastric irritation nor tenderness of the abdomen. He was discharged cured at the end of a week. In a case which occurred to Dr. Schrader, a woman, æt. 24, died from the effects of this salt taken for the purpose of procuring abortion. The symptoms were those of an irritant—severe pain, vomiting and purging. (Horn's 'Vierteljahrsschrift,' 1866, 2, 113.)

There can be no doubt that bichromate of potash is an active poison. Mr. West has published a case from which it appears that a medical man, who had inadvertently tasted a solution of it, suffered from severe symptoms resembling those of Asiatic cholera. ('Provincial Journal,' Dec. 24, 1851, p. 700.) Mr. Wood, of St. Bartholomew's Hospital, has furnished me with the particulars of a case in which two drachms of this substance destroyed the life of a woman in *four hours*. In the first two hours she suffered from violent vomiting and purging, the vomited matters being of a yellow colour. When admitted she was in a dying state, pulseless, unconscious, and breathing slowly with great effort. The skin was cold; the lower lip swollen and purple, and the tongue swollen. The chief appearances were, a dark and liquid state of the blood; the mucous membrane of the stomach was in great part destroyed, of a dark brown colour approaching to purple; the duodenum at its upper part of a florid red colour, and at its lower part much corrugated, as well as the upper half of the jejunum.

This salt, in the state of fine powder or in a saturated solution, has a local irritant action on the skin and on parts from which the skin has been removed. (See 'Ann. d'Hyg.' 1864, 1, 83.) It produces what are called 'chronic sores,' affecting chiefly the hands and exposed parts of the face. Chromic acid is a powerful corrosive poison, destroying all organic textures. (Dr. Dougall, 'Pharm. Jour.' Jan. 1872, p. 568.)

Analysis.—The bichromate may be recognized by its orange-red colour, as well as by the intense yellow colour which it gives to water when dissolved. Its solution gives a deep red precipitate with nitrate of silver, a pale yellow with nitrate of baryta, and a bright yellow with a salt of lead.

Preparations of Thallium.

The salts of this metal are, according to M. Paulet, highly poisonous, although this does not appear either from his own statement of their effects or from the experiments of M. Lamy. M. Paulet found that a dose of fifteen and a half grains of carbonate of thallium killed a rabbit in a few hours. The animal suffered from disturbance of breathing, loss of muscular power, and general trembling of the limbs; it appeared to die asphyxiated. The salts of this metal have been found to operate through the skin and cellular membrane, therefore by absorption.

Lamy dissolved seventy-five grains of the sulphate in milk, and he found that this quantity sufficed to destroy two hens, six ducks, two puppies, and a

middle-sized bitch. The prominent symptoms in the dogs were oppression of breathing, salivation, griping pains in the abdomen, the body being drawn up, with trembling and convulsions of the limbs, followed by paralysis. Vomiting and purging are not described among the symptoms. Two of the puppies did not die until four days after they had taken the poison. On opening the bodies of the animals, Lamy states that there was no mark of inflammation or other striking post-mortem appearance. In one experiment he found that a puppy died in forty hours from a dose of one grain and a half of the sulphate of thallium ('Chem. News,' Sept. 12 and 19, 1863).

The salts are soluble, colourless, and nearly tasteless, and therefore may be easily administered.

These statements of MM. Lamy and Paulet are not in accordance with the views of the discoverer of the metal, Dr. Crookes. Although much exposed to the action of the fumes, the metallic vapour produced no particular effects upon him. He also swallowed a grain or two of the salts without injury. These have a local action on the hair and skin, staining the former, and rendering the latter yellow and horny. ('Chem. News,' Oct. 3, 1863, p. 161.)

Analysis.—According to these experimentalists, the best and most certain method of detecting thallium or its oxide or salts, if used as poisons, is to dry and burn the viscera, when, by the aid of spectrum-analysis, the green band indicative of thallium will manifest itself in the spectrum from the smallest quantity of the metal, in spite of admixture with other bodies.

The history of thallium as a poison is at present very incomplete. The above facts do not show that it is an energetic substance.

VEGETABLE IRRITANTS.

CHAPTER 24.

VEGETABLE IRRITANTS—ALOES—COLOCYNTH—GAMBOGE—JALAP—SCAMMONY—SAVIN—CAPSICUM—CROTON OIL—CASTOR SEEDS—PHYSIC NUT—COLCHICUM—HELLEBORE—YELLOW JASMINE (GELSEMIUM SEMPERVIRENS)—OIL OF TURPENTINE—CAMPHINE—OIL OF TAR—CREASOTE—CARBOLIC ACID.

General Remarks.—The poisonous substances of an irritant nature which belong to the vegetable kingdom are very numerous as a class; but it will here be necessary to notice only those which have either caused death, or have given rise to accidental poisoning.

ALOES. COLOCYNTH. GAMBOGE. JALAP. SCAMMONY.

These different substances, which are used in small doses as medicines, are liable, when taken frequently or in large quantities, to excite vomiting, purging, and other symptoms of irritation. Colocynth has occasioned death in several instances: in one case a teaspoonful and a half of colocynth powder destroyed life; and one drachm of gamboge, a medicine much used by quacks, has proved fatal to man. (Traill's 'Outlines,' p. 150.) Aloes and colocynth mixed, are said to be the basis of a certain quack medicine sold under the name of Morison's Pills. These have proved fatal in many instances from the exhaustion produced by excessive purging, owing to the large quantity of these pills taken in frequently-repeated doses. Our knowledge of the symptoms and appearances produced by these irritants is, indeed, chiefly derived from the cases which have proved fatal under this pernicious treatment. In the seven-

teenth volume of the 'Medical Gazette' will be found four cases of this description. The most prominent symptom is excessive purging, with the discharge of large quantities of mucus; the individual becomes exhausted, and slowly sinks. In some instances, the symptoms are those of inflammation and ulceration of the bowels. In 1836, a man was convicted of having caused the death of a person by the administration of these pills; in this instance the death of the deceased was clearly due to the medicine, and on inspection the stomach was found inflamed and ulcerated; the mucous membrane of the small intestines was inflamed and softened, and there was the appearance of effused lymph upon it. An ingenious attempt was made in the defence to draw from the medical witness a statement that the good effects of some medicines invariably increased in proportion to the quantity taken. This was, however, very properly denied. The same remarks apply to Holloway's Pills, although these are of a more innocent description. The principal ingredient in them is aloes. In all cases it must be remembered that these drastic purgatives may cause serious symptoms, or even death, when administered to infants, or to persons debilitated by age or disease; and it is not necessary that the dose should be very large in order that fatal effects should follow. The question here will be, whether the medicine caused death, or whether it simply accelerated it: although, in a legal view, that which accelerates, causes.

Hierapicra (*Holy bitter*) is a popular aloetic compound, and one death is recorded to have been produced by it in 1837–8. There is reason to believe that it is occasionally used for the purpose of procuring criminal abortion. A man was tried and convicted of this offence at the Aylesbury Lent Assizes, 1857 (*Reg.* v. *White*), and the noxious properties of this compound then became a subject of inquiry. The dose, and the condition of the woman to whom it is administered, will of course affect the answer to this question. At the trial above mentioned, it was probably considered to be a noxious substance within the meaning of the statute. The fact that, under the name of *Pulvis Aloes cum Canellâ*, it was formerly admitted into the British Pharmacopœias, cannot justify the mischievous uses to which it may be put. *Hierapicra* is a snuff-coloured powder, of an intensely bitter taste. It consists of four parts, by weight, of aloes, and one part, by weight, of powdered Canella bark. The proper medicinal dose was formerly fixed at from five to fifteen grains. Its injurious effects on pregnant females are chiefly due to the aloes. This specially affects the rectum, and by contiguity, under violent irritation or purging, may affect the uterus. From the taste and colour which it imparts to liquids, it is not probable that it could be taken by a female unknowingly.

Death has been caused by aloes taken in nitric acid; but in this case the mineral acid was most probably the destructive agent. A singular case occurred in Germany a few years since, wherein a medico-legal question was raised respecting the poisonous properties of *Aloes*. A woman, æt. 43, not labouring under any apparent disease, swallowed two drachms of powdered aloes in coffee. Violent purging supervened, and she died on the following morning, twelve hours after having taken the medicine. On inspection the stomach was found partially, and the small intestines extensively, inflamed. There were no other particular appearances to account for death, and this was referred to the effect of the aloes.

Savin. (Juniperus Sabina.)

This is a well-known plant, the leaves of which contain an irritant poison in the form of an acrid volatile oil of a remarkable odour. They exert an irritant action, both in the state of infusion and powder. They yield by distillation a light yellow oil, on which the irritant properties of the plant depend. The powder is sometimes used in medicine, in a dose of from five to twenty

grains. Savin is not often taken as a poison for the specific purpose of destroying life; but this is occasionally an indirect result of its use as a popular means of procuring abortion. In this manner it appears to have proved fatal in one case in 1837–8. From the little that is known of its effects, it acts by producing violent pain in the abdomen, vomiting, and strangury. After death, the gullet, stomach, and intestines, with the kidneys, have been found either much inflamed or congested. It has no action as an abortive, except, like other irritants, by causing a violent shock to the system, under which the uterus may expel its contents. Such a result can never be obtained without placing in jeopardy the life of a woman; and when abortion follows, she generally falls a victim. On the other hand, a female may be killed by the poison without abortion ensuing. In May 1845, I met with a case in which death had been caused by savin-powder—abortion having first taken place. Eight ounces of green liquid were found in the stomach, which, with the gullet and the small intestines, was highly inflamed. The poison was easily identified by placing some of the minute portions of the leaves found in the stomach, under a microscope. ('Med. Gaz.' vol. 36, p. 646.) The *oil of savin* is also powerfully irritant. For an account of this, see 'CRIMINAL ABORTION.'

Fig. 35.

Tips of the leaves of Savin, magnified 30 diameters.

CAYENNE PEPPER. CAPSICUM.

A trial for manslaughter, which took place at the Central Criminal Court (*Reg.* v. *Stevens*, May 1864), renders it necessary to notice a substance much better known as a condiment than as a vegetable irritant poison. In this case a medical botanist was charged with having caused the death of the deceased, a boy, æt. 15, by administering to him dangerous medicines. The boy was suffering from diseased hip-joint, and, after taking the medicines prescribed by the prisoner, he died. Dr. Letheby examined the stomach, and found in it patches of inflammatory redness, such as would be produced by an irritant. He could detect no poison, but simply bilious matter mixed with cayenne pepper. The mixture prescribed by the prisoner contained this pepper, which the witness considered to be injurious to a person in the condition of deceased. The prisoner was acquitted, the connexion of the death of deceased with his act, being probably considered by the jury as not proved.

In small quantities, this is a well-known stimulant and a useful condiment and medicine. It has a hot, fiery taste, which lasts for a long time. It is a powerful stimulant, and in large doses produces heat in the throat, difficulty of swallowing, pain in the stomach, and inflammation of the gullet and stomach. Locally applied, it causes redness and even blistering of the skin (Wibmer, 'Arzeneimittel,' art. *Capsicum*). There is no instance recorded of its having proved fatal. It owes its irritant properties to an acrid resin (*capsicin*), of which it contains 4 per cent. From five to ten grains of the powder is considered to be a medicinal dose.

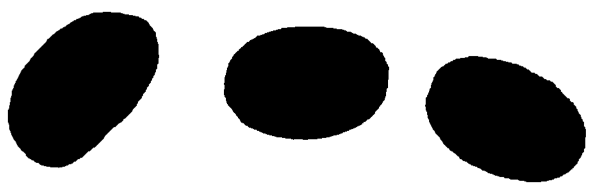
Guinea Pepper, known as Grains of Paradise, is popularly considered to be highly noxious; but there are no facts to justify this view. This kind of pepper is properly regarded as an aromatic condiment.

CROTON OIL. (CROTON TIGLIUM.)

This is an oil extracted from the seeds of the Croton tiglium. The seeds, which are sometimes called *Purging nuts*, resemble castor seeds in size and shape. The seeds have a dark brown or blackish colour, and are marked by

longitudinal lines. They have no smell. Their taste is at first mild and oleaginous, afterwards acrid and burning. When heated they evolve an acrid vapour. Croton oil is a powerful drastic purgative, producing, in a large dose, severe purging, collapse, and death. A case occurred in Paris, in 1839, in which a man swallowed by mistake two drachms and a half of croton oil. In three-quarters of an hour the surface was cold and clammy, the pulse imperceptible, breathing difficult, and the extremities and face were as blue as in the collapsed stage of cholera. In an hour and a half purging set in; the stools were passed involuntarily, and the abdomen was very sensitive to the touch. The patient complained of a burning pain in the course of the gullet. He died in four hours after swallowing the poison. There was no marked change in the mucous membrane of the stomach. For another fatal case, see 'Pharm. Journal,' Feb. 1863, p. 379. In June 1850, I was consulted in a case in which it was supposed that this liquid had been employed for the purpose of destroying a horse. In this instance sixty drops had been sold, mixed with two ounces of linseed oil.

Fig. 36.



Seeds of Croton tiglium, natural size.

In man, a dose of from fifteen to twenty drops of the *pure* oil might give rise to excessive purging, and cause death by exhaustion. The cases recorded of its fatal operation are few, and do not enable us to solve this question from observed facts. According to Landsberg (Christison's 'Dispensatory,' p. 382), thirty drops of the oil have killed a dog; and Sir R. Christison states that he has known four grains of the oil to produce an alarming degree of purging. It is frequently mixed with castor oil and other substances, and the presence of these must of course influence the dose required to act fatally. In the 'Medical Gazette' there is a report of a case in which a woman died from the effects of an embrocation containing croton oil, with other drugs. A teaspoonful was incautiously given to her: she immediately complained of a hot burning sensation in her throat. She was an aged person, and died in convulsions in three days. ('Med. Gaz.' vol. 43, p. 41.) A girl, æt. 19, took by mistake a teaspoonful of a liniment consisting of equal parts of croton and olive oil. In about half an hour she was seen by Dr. Brydon, and she then complained of an intense burning sensation in the throat and gullet; but there was no pain in the stomach. Her pulse was 84. Vomiting came on in a severe form, and this was promoted by a zinc emetic and warm water. After the vomiting had continued for a quarter of an hour, she complained of a severe pain in the stomach. Purging was not a prominent symptom. In a day or two she recovered. ('Edinburgh Medical Journal,' Aug. 1861.) In another case a little girl six years old took by mistake about fifty-five drops of croton oil. There was vomiting, with some purging and feverishness for three or four days, but the patient recovered. ('Lancet,' 1870, 1, 553.) In these cases it is not improbable that the oil may have been adulterated. In one case reported, a child, æt. thirteen months, died in six hours from a small dose given by mistake. The croton oil was mixed with soap liniment, and the quantity taken was supposed to be less than three minims of the oil. ('Med. Times and Gaz.' 1870, 2, 466.)

M. Chevallier reports two cases of poisoning by this oil. In one a druggist swallowed by mistake for cod liver oil half an ounce of croton oil. He felt a burning sensation in the throat and stomach, soon followed by vomiting and copious purging, with symptoms of collapse. He did not recover until after a fortnight. In the other case, quoted from Devergie, a man, æt. 25, swallowed by mistake two drachms and a half of the oil. The most violent purging with collapse took place, and the patient died in four hours. ('Ann. d'Hyg.' 1871, 1, 409.)

A case was tried at the Liverpool Winter Assizes (*Reg.* v. *Massey and*

Ferrand), in which the prisoners were charged with having caused the death of a man by placing in food, of which he and others had partaken, two drachms of powdered jalap, and from two to six drops of croton oil. Several persons, including the deceased, suffered from vomiting and purging; but they recovered, and the deceased himself so far recovered as to be able to go about as usual. He was subsequently attacked with inflammation and ulceration of the bowels, from which he died. The prisoners were acquitted, as the medical evidence at the trial failed to make out the connexion of this subsequent illness with the jalap and croton oil which had been put into the food.

Physic Nut (Jatropha Curcas).

The Jatropha Curcas is a West-Indian plant which produces seeds containing an acrid oil, having some of the properties of croton oil. Four seeds act as a violent cathartic, and severe vomiting and purging have been produced by a few grains of the cake left after the expression of the fixed oil from the bruised seeds. The oil operates powerfully in a dose of from twelve to fifteen drops. It produces a burning sensation in the throat, vomiting and purging, and other symptoms of irritation, followed by inflammation of the stomach and bowels. In August 1858, 139 children in Dublin suffered from the effects of these seeds ('Medical Times and Gazette,' Aug. 1858); and in June 1864, a number of boys at Birmingham suffered severely from eating some of these nuts which they had found in a drug-store, but they all recovered. M. Chevallier refers to a case in which thirty-three persons were poisoned by eating these seeds. The *symptoms* from which they suffered were nausea, vomiting, and general depression. Twenty were so ill that they were placed in the beds of an hospital; the remaining thirteen soon recovered. The albumen of this seed, as well as that of the castor, is said to have a flavour resembling that of the almond. ('Annales d'Hyg.' 1871, 1, 408.)

The *Jatropha urens*, also a West-Indian plant, is said to produce serious effects upon those who touch its leaves, which are covered with stinging hairs like those of the nettle. One of these plants was raised at Kew from seeds sent from Trinidad. Mr. Jackson, of the Kew Museum, gives the following account of the effects of contact. The wrist of a person accidentally came in contact with some of the hairs. In a few minutes there was swelling of the lips, redness of the face, faintness, great prostration of strength, and such a degree of collapse, that for some minutes the sufferer was thought to be dead. He then rallied; there was sickness, and in twenty minutes the man recovered. In another case the pain and swelling in the part touched lasted for some days, and an itching sensation continued for a longer period. ('Pharm. Jour.' April 17, 1872, p. 863.) Assuming this account of the symptoms to be correct, the poison connected with the hairs not only has a local action, but it is very rapidly absorbed, and produces effects resembling those of serpent poison.

Castor Seeds (Ricinus Communis).

Of castor oil itself nothing need be said. It is not commonly known that the seeds from which this oil is extracted, contain in the embryo an active poison, and that a few of them are sufficient to produce serious symptoms. Thus three or four seeds may act powerfully on an adult. Eight may give rise to serious symptoms, and a larger number may destroy life.

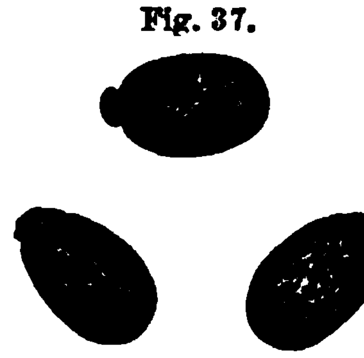
Symptoms and Appearances.—The symptoms which mark this form of poisoning are the absence of a disagreeable taste or sense of heat in the mouth and throat at the time of eating the seeds. Soon after the pulp has been swallowed, there is severe pain in the abdomen, copious and painful vomiting, with bloody purging, thirst, and convulsions, terminated by death. (Bouchardat, 'Ann. de Thérapeutique,' 1872, p. 103.) A girl, æt. 18, the sister of a gentleman who was at the time attending my lectures at Guy's Hospital, ate

about twenty castor-oil seeds; one of her sisters ate four or five, and another two. This was on a Wednesday evening. In the night they were all taken ill. About five hours after the seeds were eaten, the deceased felt faint and sick; vomiting and purging came on, and continued through the night. On the following morning she appeared like one affected with malignant cholera. The skin was cold and dark-coloured, the features contracted, and the breath cold; the pulse was small and wiry; there was restlessness, thirst, pain in the abdomen, and she lay in a sort of drowsy, half-conscious state. Whatever liquid was taken was immediately rejected, and the matters passed by stool consisted chiefly of a serous fluid with blood. She died in five days without rallying; the two other sisters recovered. On inspection, a large portion of the mucous membrane of the stomach was found abraded and softened in the course of the great curvature. A similar case, in which three seeds destroyed the life of a man in forty-six hours, is reported in the 'Med. Times and Gaz.' May 25, 1861, p. 555. There was general redness of the stomach, and the abraded portion presented the appearance of a granulating surface of a pale rose-colour; it was covered by a considerable quantity of slimy mucus. The small intestines were inflamed, and the inner surface of them was abraded. The effects produced on the sisters who recovered, bear out the statement of Sir R. Christison, that two or three of the seeds will operate as a violent cathartic. Other cases, including one which proved fatal, are recorded by M. Chevallier in the 'Annales d'Hyg.' 1871, 1, 400. A woman swallowed a quantity of the seeds bruised, in place of castor oil. She was soon seized with violent vomiting and bloody stools, which continued until her death on the fifth day after taking the seeds. The mucous membrane of the stomach and bowels was of a dark colour, much ecchymosed, and presented patches of small extravasations of blood.

An officer took as a purgative seventeen seeds. In three hours there was violent purging, followed by vomiting and severe cramps, the patient passing into a condition resembling the collapse of Asiatic cholera. The vomiting was not stopped until after twenty-one hours, and recovery then took place. There was suppression of urine for forty-eight hours (Wiggers' and Husemann's 'Jahresbericht,' 1872, p. 538). The cake left after the pressure of the oil is poisonous to rats as well as human beings (Chevallier). When the seeds are swallowed whole, they may fail to produce the severe symptoms above described.

Mr. Little reports two cases of children aged respectively six and three years, in which recovery took place, although the seeds had been masticated. The children when brought to the hospital were suffering from extreme collapse, consequent on vomiting and purging, the body pale and perspiring, pulse 130. The night before admission the children had eaten some castor-oil seeds. They suffered severely through the night. The stools were frequent and watery. The substance thrown from the stomach was pulpy; there was pain in the abdomen, great thirst, and the tongue was furred and dry. There were no cerebral symptoms. Under treatment, they both recovered in two days. ('Med. Times and Gaz.' 1870, 1, 581.)

Fig. 37.



Castor seeds, natural size.

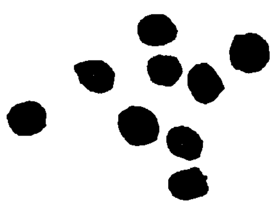
Analysis.—Castor *seeds* could only be identified in the contents of the stomach provided a portion of the outer coat could be obtained. These seeds are remarkable for their peculiarly variegated surface. Externally they are of a pale grey, but marbled with yellowish brown spots and stripes.

MEADOW-SAFFRON (COLCHICUM).

Meadow saffron (COLCHICUM AUTUMNALE) contains a poisonous alkaloid—*Colchicina*—the effects of which on animals are similar to those of *Veratria*,

the alkaloid existing in White Hellebore. The most noxious parts of the plant are the bulbs (or roots) and seeds, but the leaves and flowers have also an irritant action. Three deaths from colchicum are reported to have occurred in four years (1863–7). The *seeds* of colchicum are of a brown colour, varying from pale to dark. They are without smell, but have a bitter acrid taste. In size and colour they somewhat resemble grains of paradise, and have been mistaken for them. Their shape and size are represented in the annexed engraving.

Fig. 38.



Colchicum seeds, natural size.

Symptoms and Appearances.—In November 1839, a gentleman swallowed by mistake one ounce and a half of *wine* of colchicum. He was immediately seized with severe pain in the abdomen: other symptoms of irritation came on, and he died in seven hours. No examination of the body was made! In another instance, in which an ounce of the wine was taken, death occurred in thirty-nine hours. (Schneider's 'Annalen,' vol. 1, p. 232.) In a case in which a similar dose was taken, the person recovered after suffering from cramps in the limbs and twitching of the tendons. ('L'Union Méd.' Aug. 24, 1848.) A woman, æt. 56, suffering from rheumatism, for whom wine of colchicum had been prescribed, took by mistake an ounce of the wine of the seeds, in divided doses, in twelve hours. She suffered from nausea, violent and profuse vomiting, slight purging, with heat and burning pain in the throat, great thirst, cold clammy skin, feeble pulse, pain in the stomach, and pain in the forehead. Inflammation of the stomach supervened, and the retching, vomiting, thirst, and pain continued for three days. She then recovered. ('Amer. Jour. Med. Sci.' Jan. 1857; and 'Brit. and For. Rev.' 1857, 19, 409.) In other cases profuse purging has been the most prominent symptom, followed by death from exhaustion. ('Pharm. Jour.' July 1861, p. 45.) In one instance, in which two ounces of the wine were taken, the symptoms did not come on for an hour and a half; there was then copious vomiting of a yellow fluid, severe pain with great tenderness in the abdomen, tenesmus and thirst. The patient died in forty-eight hours, without being convulsed or manifesting any sign of cerebral disturbance. The chief morbid *appearance* was a patch of redness in the mucous membrane of the stomach, near the cardiac orifice; the intestines were slightly inflamed. The head was not examined. ('Medical Gazette,' vol. 10, p. 161; see also Casper, 'Ger. Med.' vol. 1, p. 450.) A case of poisoning by the medicinal administration of colchicum, has been communicated to me by Mr. Mann, of Bartholomew Close. Three and a half drachms of the wine of colchicum were taken in divided doses, and caused death on the fourth day. There was no inflammation of the mucous membrane, but simply extravasation of blood into the mucous follicles. The mucous membrane has been found softened in two cases of poisoning by the tincture. In two other cases, in which an ounce and a half of the *tincture* was taken, and death ensued in forty-eight hours, no morbid appearances were found. (Casper, 'Ger. Med.' 1857, 1, 451.) For a case of alleged poisoning by wine of colchicum, see Casper's 'Vierteljahrsschrift,' 1860, 1, 1.

Colchicum has acquired an evil notoriety as a poison chiefly owing to the evidence given at a trial which took place at the Central Criminal Court, in September 1862 (*Reg.* v. *Catherine Wilson*). This woman, after having been tried and acquitted for an attempt to poison, with oil of vitriol, the wife of a man with whom she cohabited, was in the following September convicted of the murder of a *Mrs. Soames*, who had died suddenly while nursed by the prisoner six years previously. The body was exhumed, but no poison was found in the remains; yet the medical and other circumstances, as well as the conduct and correspondence of the prisoner, proved to the satisfaction of the Court that deceased had been destroyed by vegetable poison, most probably colchicum, with the noxious properties of which she was proved to have been

well acquainted. From the facts which transpired in reference to this trial, it appeared that the deceased was one of four persons who had at different dates fallen victims to the acts of this woman. 1st, *Peter Mawer*, a master mariner of Boston, died in October 1854: the body was exhumed in 1862, but no poison was detected. 2nd, *Mrs. Jackson*, of Boston, who died in December 1859: the body was exhumed in January 1860, and no poison detected. 3rd, *Mrs. Atkinson*, of Kirkby Lonsdale, who died in October 1860: the body was exhumed in May 1862, and no poison detected. 4th, the case of *Mrs. Soames*, above mentioned. All these persons died suddenly while in a state of health, under similar symptoms, and without any apparent natural cause to account for death. The symptoms as a whole were not reconcilable with any known disease; and they only appeared after the prisoner was proved to have administered, under some pretence or other, food or medicine, the bottle which she employed for this purpose being kept locked up, or in her own possession. The motive for the murder, in each case, was the acquisition of money or property of which the prisoner came into possession—in Peter Mawer's case by a will made shortly before his death, and in Mrs. Atkinson's case by an act of robbery after her death. Two other attempts at murder which failed, led to the inference that colchicum was the substance which this woman employed, either in wine or brandy. In these four persons, the symptoms were as nearly as possible of the same character—burning pain in the throat and stomach, intense thirst, violent vomiting and purging, coldness and clamminess of the skin, excessive depression and great weakness. The pulse was small and weak, and death appeared to take place, without convulsions or loss of consciousness, from complete exhaustion. Of these persons, one died on the second, one on the fifth, one on the eighth, and one on the fourteenth day. In most of the cases the poison was probably given in divided doses: in the last case, the symptoms always appeared every evening after the deceased had taken the tea prepared by the prisoner.

Analysis.—Colchicum in the form of tincture possesses a warm aromatic taste and a peculiar odour. It owes its properties to the alkaloid *colchicina*, which is held dissolved by an acid. The process for detecting this substance consists in neutralizing with potash a portion of the aqueous acid solution (obtained by evaporating the alcoholic tincture) and then adding twice its volume of ether. The mixture should be well shaken. On pouring off the ether, and letting it evaporate spontaneously, an imperfectly crystalline or uncrystalline residue remains. (See 'Pharm. Jour.' 1857, p. 529.) When this is treated with one or two drops of concentrated nitric acid, the presence of colchicina is indicated by the residue acquiring a reddish-violet colour, which soon disappears.

Black White and Green Hellebore.

Symptoms and Appearances.—According to Wibmer, the roots of the black hellebore possess the greatest activity: but the leaves are also highly poisonous when used in the form of infusion. By long boiling the poisonous properties of the plant are diminished, probably owing to the loss of the volatile principle, which is an acrid oil. The roots and leaves have a local irritant action, producing violent vomiting and purging in small doses, with severe pain in the abdomen, followed by cold sweats, convulsions, insensibility and death. The powdered root, in a dose of a few grains, acts like a drastic purgative. In a case reported by Morgagni, half a drachm of the aqueous extract killed a man, æt. 50, in eight hours. The symptoms were severe pain in the abdomen and violent vomiting. After death the whole of the alimentary canal was found inflamed, but especially the large intestines. (Wibmer, op. cit. *Helleborus.*) A case is quoted by the same writer, in which a table-spoonful of the finely-

powdered root (taken by mistake for rhubarb) caused severe symptoms of irritant poisoning, which did not disappear for four hours. The man recovered on the fourth day. The experiments performed by Orfila on animals, show that this poison acts like a *local* irritant when applied to a wound. (Op. cit. vol. 2, p. 369.) Hellebore is a favourite remedy for worms with quacks and rural doctresses. It is not, therefore, surprising that it should be occasionally administered in an overdose, and cause death. In December 1862, Dr. Edwards met with a case in which a gentleman had swallowed experimentally one drachm of tincture of green hellebore (*veratrium viride*), equal to twelve grains of the powder. He was found soon afterwards in a collapsed state, features sunk, skin cold, and covered with a profuse clammy sweat, pulse scarcely perceptible. He complained of intense pain in the region of the stomach. There was no purging. These symptoms were relieved by treatment, and the next morning the patient had recovered. ('Med. Times and Gazette,' 1863, 1, 5.)

VERATRIA.—White hellebore owes its noxious properties to the alkaloid *veratria*, which is itself a powerful poison. The late Mr. Callaway communicated to me the following case. A physician prescribed medicinally for a lady, one grain of veratria divided into fifty pills, and three were directed to be taken for a dose. Not long after the first dose had been swallowed, the patient was found insensible, the surface cold, the pulse failing, and there was every symptom of approaching dissolution. She remained some hours in a doubtful condition, but ultimately recovered. Supposing the medicine to have been well mixed, and the pills equally divided, not more than one-sixteenth of a grain of veratria was here taken! This cases proves that pure veratria is capable of exerting a powerful effect. The common veratria of the shops is sometimes given medicinally, in doses of one-sixth of a grain. In the pure state, it forms a brownish-white uncrystalline powder, scarcely soluble in water even on boiling; but is more readily dissolved by alcohol and ether. It has a faint alkaline reaction, and easily combines with the acetic and other acids, forming soluble salts. It has a hot, acrid taste, without any bitterness. Strong nitric acid gives to it a light red, turning to an ochreous colour. Diluted sulphuric acid, when heated with the powder, or a residue containing veratria, produces an intense crimson-red colour. Veratria differs from colchicina in not being very soluble in water, and in the action of strong nitric as well as of diluted sulphuric acid. It undergoes no change of colour with iodic acid or sulphomolybdic acid.

YELLOW JASMINE (GELSEMIUM SEMPERVIRENS).

An alcoholic extract of the root of this plant has been used in the United States for medicinal purposes. It has acted as a poison and destroyed life, but its exact place as a poison cannot yet be satisfactorily assigned. From a case reported by Dr. Wormley ('American Journal of Pharmacy,' Jan. 1870), it appears to belong rather to the irritant than the narcotic class of substances.

A young healthy married woman took by mistake three teaspoonfuls of the fluid extract of gelsemium—a concentrated tincture of the root containing 480 grains to the ounce. She was several weeks advanced in pregnancy. In two hours after taking the extract, she complained of pain in the stomach, nausea, and dimness of vision. These *symptoms* were followed by great restlessness, ineffectual efforts to vomit, and general perspiration. In four hours the pulse was feeble, irregular, and intermittent. There was great prostration, with irregular and slow breathing. The skin was dry, the limbs were cold, the pupils dilated and insensible to light; the eyes were fixed, and there was inability to raise the eyelids. The vital powers rapidly gave way, and, without convulsions, death occurred in seven hours and a half after the poison had been taken. On *inspection* the membranes and substance of the brain and

spinal marrow were normal. The adipose tissue was thick and tinged with bilious matter. The lungs were collapsed, but natural in appearance, and the superficial veins were congested. The heart was normal—the superficial veins were injected and the cavities were distended with dark grumous blood, inside of which was a well defined fibrinous deposit. The stomach contained a small quantity of ingesta: the peritoneum and intestines were in a healthy state. The left kidney was congested.

It will be seen from this account that while death took place rapidly there was nothing characteristic in the symptoms and appearances.

Analysis.—Dr. Wormley discovered that the extract contained an alkaloid (*gelseminine*) separable by ether or choloform and an organic acid (*gelseminic acid*). The latter he was able to obtain crystallized in various forms by solution and sublimation. He found that if a small quantity of this acid or its salts in a solid state was treated with a drop of concentrated nitric acid, it became yellow or reddish, according to the quantity. When an excess of ammonia was added, it acquired a blood-red colour. The hundredth part of a grain was sufficient for this reaction. The solution in potash is fluorescent, presenting a deep blue colouration on the surface. Gelseminic acid was thus detected in the contents of the stomach some months after death.

The alkaloid *gelseminine* is, according to Dr. Wormley, a potent poison. One-eighth of a grain by hypodermic injection killed a rabbit in one hour and a half. In fifteen minutes there were symptoms of great distress, and the animal was restless. In forty minutes there was great prostration, inability to move, respiration gasping, and the pupils were dilated, but there were no convulsions. From his experiments Dr. Wormley infers that the quantity which proved fatal to the woman in the above-mentioned case could not have exceeded the sixth part of a grain.

Oil of Turpentine. Camphine.

The few cases in which this liquid has produced any noxious symptoms have occurred among children. From these it appears to have rather the effects of a neurotic (narcotic) than an irritant poison. In a dose of three drachms it has produced intoxication. A dose of a table-spoonful caused in a child, aged eighteen months, symptoms bearing a strong resemblance to those occasioned by an overdose of opium, although they were not so rapidly manifested. (See case by Mr. Johnson, 'Med. Times,' Oct. 11, 1851, p. 380.) In three hours there was complete insensibility, with stertorous breathing, strongly contracted pupils, rapid and weak pulse, coldness of surface, paleness of the countenance, general relaxation of the muscles, and occasional convulsive movements. Two fatal cases are recorded. The first was the case of a child, aged fourteen weeks. It occurred in January 1869. I am indebted to Mr. Miall, of the Bradford Infirmary, for the particulars. The evidence at the inquest showed that the child had had half an ounce of the oil poured down its throat by a brother æt. 8. It had been left asleep at 9 P.M. and in an hour it was found to be insensible, cold, and slightly convulsed. At about 12 P.M. it was seen by Mr. Miall. It was comatose, pale, with extremely cold surface—pupils contracted; slow and irregular breathing about three times in a minute, pulse quick, small, compressible, almost imperceptible. A strong odour of turpentine issued from the mouth, and there was a spot of liquid on the pillow. The child was unable to swallow. It died in fifteen hours after taking the poison. The second case occurred in Birkenhead in July 1872. The child was five months old. A spoonful of spirit of turpentine was given to it by mistake for peppermint, and death took place rapidly. ('Pharm. Jour.' July 1872, p. 75.) Oil of turpentine is occasionally given to children suffering from worms. The above cases should inspire caution.

CAMPHINE is oil of turpentine simply purified by distillation with lime. A case of poisoning by this rectified oil occurred to Dr. Thomsen of Schleswig. A woman, æt. 22, swallowed a large quantity of this liquid. She was soon seized with violent vomiting, which was increased by milk and other liquids. The matter vomited smelt strongly of turpentine. She was restless, and in great pain; there was some purging. There was not an entire loss of consciousness. In two hours she complained of cold, the pulse was small and weak; the head then became hot, there was headache, but the pupils were unchanged; there was redness of the conjunctivæ. A quantity of urine was passed smelling of violets, and the breath also had a similar odour. There were some slight nervous symptoms, but these passed off. She recovered in eight days. (Horn's 'Vierteljahrsschrift,' 1866, 2, 337.)

A case of recovery in an infant that had swallowed four ounces of the oil is described in another work ('ON POISONS'). A case in which this liquid was criminally administered to an infant, was the subject of a trial at the Central Criminal Court, December 1856 (*Reg.* v. *Rodanbosh*): it did not destroy life, but the child suffered for some time from the effects. The defence was, that the oil of turpentine was poured down the child's throat by the mother with a view to cure it of a cough! She was acquitted.

OIL OF TAR. CREASOTE. CARBOLIC ACID.

The oil of tar is a powerful vegetable irritant. In 1832, about ten drachms of it caused the death of a gentleman, to whom it had been sent by mistake for a black draught. The druggist who sent it was tried for manslaughter, but acquitted. Its irritant properties are owing to creasote, carbolic acid, and other compounds. Of these the most important in a practical point of view is carbolic acid, which has come into considerable use of late years as a disinfectant.

CARBOLIC ACID is a crystalline product of the fractional distillation of the oil of tar. In an impure state it has been long known as creasote. The crystals of carbolic acid melt at 95°, and the oily-looking liquid boils and is entirely volatilized at 370°. It is sold commercially in a liquid form. Many instances of poisoning by this substance are now on record, the greater number having arisen from accident. It has such a powerful odour and taste that it could not be easily administered with homicidal intent. In a concentrated form it has a strong local action, and is a corrosive irritant, but it affects the brain like a narcotic poison. It acts on the unbroken skin, whitens it, hardens it, and destroys its sensibility for some time. It acts in a similar way on the mucous membrane, whitening, hardening, and corrugating it. In one instance it is reported to have destroyed life as the result of external application. ('Brit. Med. Journal,' Oct. 8, 1870.) Five deaths are recorded to have taken place from this poison in four years (1863–7).

Symptoms and Appearances.—When the poison is swallowed in solution in a moderately concentrated state, the patient experiences a hot burning sensation extending from the mouth to the stomach. The symptoms come on in the act of swallowing; the lining membrane of the mouth is whitened and hardened. There is severe pain in the stomach, with vomiting of a frothy mucus. The skin is cold and clammy, the lips, eyelids, and ears are livid; the pulse 120 and intermittent; breathing difficult, with frothing at the mouth. There is insensibility, which comes on speedily, and passes into coma with stertorous breathing; a strong odour of carbolic acid in the breath and in the room; the pupils are contracted and insensible to light. The motions and urine, when passed, have been dark-coloured. Among the *appearances* after death the following have been observed: the interior of the mouth and jaws whitened, sometimes corroded; the œsophagus also white, hard, and corru-

gated. The coats of the stomach have presented a horny consistency, without any signs of inflammation. The lungs have been found gorged with blood, and the bronchia filled with a brown-red thick mucus.

Fatal dose.—A woman died from swallowing a wine-glassful of carbolic acid, probably a weak aqueous solution. She did not speak after taking it, and died in about half an hour. ('Pharm. Jour.' July 1872, p. 75.) In 1867, a child, under two years, was brought into Guy's Hospital labouring under the effects of this poison. It had taken two teaspoonfuls of the ordinary brown liquid carbolic acid. This proved fatal in twelve hours. ('Guy's Hospital Reports,' 1867, p. 233.) In another case a tablespoonful proved fatal to a young man.

It has caused death rapidly. In a case which occurred to Mr. Jeffreys, an adult died in fifty minutes after taking from one to two tablespoonfuls of the liquid acid. (See Husemann's 'Jahresbericht,' 1872, p. 523.)

Analysis.—The strong and peculiar odour perceptible in the breath, in the vomited matters and in the room, generally suffice to indicate the nature of the poison. Carbolic acid is partially dissolved by water, and is very soluble in alcohol or solution of potash. It has no acid reaction: it gives a greasy stain to paper, and burns with a smoky flame. There is no test for its presence so delicate as the odour. The persulphate of iron and chloride of lime and ammonia fail to act satisfactorily in mixtures in which the characteristic smell of the acid can be perceived.

ANIMAL IRRITANTS.

CHAPTER 25.

ANIMAL IRRITANTS—CANTHARIDES OR SPANISH FLIES—SYMPTOMS AND EFFECTS—ANALYSIS—POISONOUS ANIMAL FOOD—FISH—MUSSELS—CHEESE—SAUSAGES—DISEASED FLESH OF ANIMALS—TRICHINOSIS.

CANTHARIDES (SPANISH FLIES).

Symptoms and Effects.—Cantharides are not unfrequently administered, either in the state of powder or tincture, for the criminal purpose of procuring abortion, but they are not often a cause of death in this country. Out of 1,620 fatal cases of poisoning in four years, there were only two which were ascribed to cantharides. When taken in *powder*, in the dose of one or two drachms, it gives rise to the following symptoms: a burning sensation in the throat, with great difficulty of swallowing, violent pain in the abdomen, with nausea, and vomiting of bloody mucus: there is also great thirst and dryness of the throat, and in a few cases observed by Mr. Maxwell, salivation was a prominent symptom. As the case proceeds, a heavy dull pain is commonly experienced in the loins, and there is an incessant desire to void urine, but only a small quantity of blood or bloody urine is passed at each effort. The abdominal pain becomes of a violent griping kind. Purging supervenes, but this is a symptom which is not always observed: the matters discharged from the bowels are mixed with blood and mucus, and there is often tenesmus (straining). In these, as well as in the vomited liquids, shining green or copper-coloured particles may be commonly seen on examination, whereby the nature of the poison taken, if it has been taken in powder, will be at once indicated. After a time, there is severe priapism, and the genital organs are swollen and

inflamed both in the male and female. In one instance, observed by the late Dr. Pereira, abortion was induced, probably owing to excitement of the uterus, from the severe affection of the bladder: for there is no proof that this substance acts directly on the uterus to induce abortion. With respect to the aphrodisiac propensities said to be caused by cantharides, these can seldom be excited in either sex, except when the substance is administered in a dose which would seriously endanger life. When the case proves fatal, death is usually preceded by faintness, giddiness, and convulsions. The *tincture* of cantharides produces similar symptoms:—they are, however, more speedily induced, and the burning sensation and constriction of the throat and stomach are more strongly marked: this symptom is often so severe as to render it impossible for the person to swallow; and the act of swallowing gives rise to excruciating pain in the throat and abdomen. Cantharides have been in some cases wantonly used, and with great danger to life, with a view of exciting sexual feelings. The doses in which it has been given have been such as to cause symptoms of irritant poisoning. In Nov. 1859, six female servants in a gentleman's family, as well as the master and mistress, were attacked with all the symptoms of poisoning by cantharides. It appeared that the coachman of the family had, shortly before the occurrence, purchased an ounce of this poison; that he had put the cantharides into beer and coffee, and had thus poisoned the whole household. He was tried, but acquitted of any indictable offence, on the ground that his intent was not to murder. It was this case which led to an alteration in the law.

Appearances.—In one well-marked instance of poisoning by this substance, the whole of the alimentary canal, from the mouth downwards, was in a state of inflammation. The mouth and tongue seemed to be deprived of their mucous membrane. The ureters, kidneys, and internal organs of generation were also inflamed. In another instance, in which an ounce of the tincture was swallowed, and death did not occur for fourteen days, the mucous membrane of the stomach was not inflamed; but it was pulpy, and easily detached. The kidneys were, however, inflamed. The brain has been found congested, and ulceration of the bladder is said to have been met with. There are few fatal cases reported, in which the appearances have been accurately noted; indeed, the greater number of those who have taken this poison have recovered. In a case which occurred to Mr. Saunders, death took place in about twenty-four hours. The deceased must have taken the greater part of half an ounce of cantharides in powder. The symptoms were such as have been above described. On inspection the vessels of the brain were filled with dark-coloured blood, and the ventricles were distended with serum. Both lungs were highly engorged with dark-coloured blood. The gullet was partially inflamed, and there were patches of inflammation on the mucous coat of the stomach, which had become detached in several places. The same inflammatory appearance existed in the small intestines, in the folds of which the powder of cantharides was abundantly present. The vessels were distended, and the liver was engorged with dark blood. The gall-bladder was much distended with bile, and none of this secretion appeared to have passed into the bowels. The spleen and kidneys were highly congested; the ureters were inflamed; the bladder was contracted and empty, and its internal surface pale. The glittering of the particles of cantharides in the viscera during the inspection by candlelight, was very remarkable. ('Medical Times,' Feb. 3, 1849, p. 287.) Cantharides have no local action of a chemical nature. The poison is a pure *irritant*, and the effects observed on the stomach are entirely due to irritation and inflammation.

The *quantity* of this poison required to produce serious symptoms, or to destroy life, has been a frequent subject of medico-legal inquiry. Dr. Thomson represents the medicinal dose of the powder to be from one to three grains.

On a late criminal investigation a medical witness stated that one grain was the maximum dose, but this is an under statement: according to Thomson it is three grains. The dose of the tincture is from ten minims gradually increased to one fluid-drachm,—of the powder from *one* to *two grains*. (Pereira, 'Mat. Med.' part 2, vol. 2, p. 754.) Doses above this, whether of the powder or the tincture, are likely to be injurious, and to give rise to symptoms of poisoning. On a trial which took place at Aberdeen, in 1825, it appeared that a drachm of the powder had been administered: severe symptoms followed, but the person recovered. Dr. Dyce, the medical witness, said he had given ten grains of the powder as a medicinal dose. In three cases, observed by Mr. Maxwell, a drachm of the powder mixed with six ounces of rum was taken by each person: they were robust, healthy negroes, they suffered severely, but recovered in about ten days. In these cases, irritation of the urinary organs did not appear until after the men had been bled.

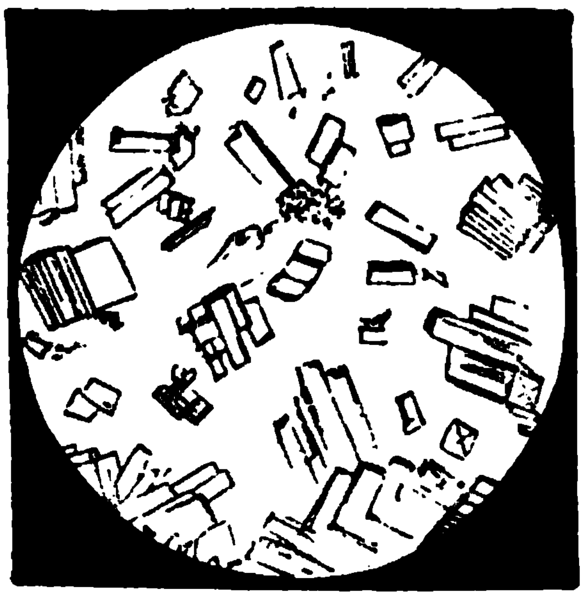
Fatal Dose.—The *smallest quantity* of the powder which has been known to destroy life, was in the case of a young woman, quoted by Orfila,—the quantity taken was estimated at *twenty-four grains* in two doses. She died in four days; but as abortion preceded death, this may have been concerned in accelerating that event. Her intellect was clear until the last. In one instance a man recovered after having taken twenty grains of the powder ('Ed. Med. and Surg. Journal.' Oct. 1844); and in another, after having taken *two drachms* ('Med. Gaz.' vol. 42, p. 873). An *ounce* of the tincture has been known to destroy life. This dose was taken by a boy, æt. 17, and he died in fourteen days. This, I believe, is the smallest dose of the tincture which has proved fatal. Four drachms and even six drachms have been taken; and although the usual symptoms followed, the parties recovered. The last case was the subject of a trial at the Central Criminal Court, in September 1836. Six drachms of the tincture were administered to a girl, æt. 17: the questions here arose whether half an ounce was sufficient to kill a person, as also what proportion of cantharides was contained in an ounce of the tincture. One ounce of the tincture is considered to be equivalent to five and a half grains of the powder; but as the proportion of *cantharidine*, the substance on which the poisonous properties depend, is subject to variation, it is not unlikely that the tincture varies in strength. A case is quoted by Pereira, from Dr. Hosack ('Mat. Med.' vol. 2, pt. 2, p. 750), in which it is said six ounces of the tincture were taken by a man without causing dangerous symptoms! This must have been an unusually weak preparation; and probably the insects from which the tincture was made, contained little or no cantharidine. The same writer mentions a case within his own knowledge in which one ounce of the tincture caused serious symptoms. The powder cannot be so readily administered as the tincture, since a large portion of it floats for a time on any liquid with which it is mixed, and attracts attention by its peculiar appearance. At the Liverpool Lent Assizes, 1861 (*Reg.* v. *Wilkins*) a man was indicted for administering powdered cantharides to a woman. The prisoner had mixed it with a cup of tea: the prosecutrix took a portion of the tea and suffered from vomiting and other symptoms produced by this substance: she skimmed a quantity of the powder from the tea, on which it floated, and its nature was then easily determined. The prisoner was convicted of the act of administration, but a serious question arose in reference to the intent. The jury found that he had administered the powder with the intent to excite the sexual passion of the woman, for which the new statute had not provided, as this makes the offence to depend only on the intent to injure, aggrieve, or annoy!

Chemical Analysis.—For the detection of *cantharidine*, which forms on an average only 1-250th part of the flies, it has been recommended to digest the suspected solid or the liquid contents of the stomach (evaporated to an extract)

in successive quantities of ether, to concentrate these ethereal solutions by slow evaporation, and then observe whether the concentrated liquid applied to the skin of the lips produces vesication or not: the medical jurist being expected in such cases to make himself the subject of experiment. By this method Barruel discovered cantharides in some chocolate. ('Ann. d'Hyg.' 1835, 1, 455.) For the detection of the powder, M. Poumet recommends that the suspected liquids, mixed with alcohol, should be spread on sheets of glass, and allowed to evaporate spontaneously to dryness. The shining scales will then be seen, on examining by reflected light either one or both surfaces of the glass. ('Ann. d'Hyg.' Oct. 1842.) As the powder is insoluble in water, some portion of it may be obtained by washing and decantation. The sediment may be examined on a glass slide with the microscope.

Cantharidine is a neutral crystallizable principle. I subjoin illustrations of its crystalline form, obtained by the spontaneous evaporation of its solutions in ether and chloroform:—

Fig. 39.



Crystals of Cantharidine from a solution in chloroform, magnified 80 diameters.

Fig. 40.

Crystals of Cantharidine from a solution in ether, magnified 80 diameters.

As ten grains of the powder contain only the 1-25th part of a grain, it will not be in the power of an analyst to extract cantharidine unless the powder is present in comparatively large quantity. The 1-100th of a grain of cantharidine dissolved in ether is said to possess vesicating properties.

Mr. Tichborne recommends, in place of ether, the use of chloroform for the separation of cantharidine from the tincture or from an alcoholic or aqueous extract of the contents of the stomach. He added a quantity of tincture equivalent to three grains of powdered flies (four drachms) to half a pint of wine: one ounce of chloroform was frequently shaken with this mixture and left in contact with it twenty-four hours. The chloroform was then separated by a funnel and filtered; it was allowed to evaporate spontaneously in a watch-glass. A pellet of lint of the size of half a pea, pulled out, was moistened with a drop of olive-oil, and the residue in the watch-glass was taken up by it. It was placed upon the arm and covered with goldbeaters' skin. When taken off in three or four hours, the skin was very red, and, on wiping it with chloroform, a large vesicle was produced. ('Chem. News,' Feb. 14, 1863, p. 78.) The quantity of cantharidine here detected, amounted to only the 1-80th part of a grain. This mode of operating is certainly preferable to the use of ether, as cantharidine is less soluble in ether than in chloroform. I have ascertained by experiment that half an ounce of the tincture of cantharides will yield to chloroform a crystallizable principle, having the characters assigned to cantharidine. In practice it will be found advisable to concentrate the liquid as much as possible before adding the chloroform, and to employ two measures of chloroform for one measure of the liquid for analysis.

The evidence of the presence of cantharides, or of their having been taken,

is necessary to support a criminal charge; for however unambiguous the symptoms produced by this poison may appear to be in its peculiar effects on the generative and urinary apparatus, the medical jurist should be aware that similar symptoms may proceed from disease. An important case of this kind has been reported by Dr. Hastings. ('Med. Gaz.' vol. 12, p. 431.) A young lady was suddenly seized with vomiting, thrist, pain in the loins, strangury, and considerable discharge of blood from the urethra: the generative organs were swollen and painful. She died in four days. She was governess in a family, and there was some suspicion that she had been poisoned with cantharides. The stomach and the kidneys were found inflamed, and the bladder also; this contained about two ounces of blood. There was no trace of poison; and indeed it was pretty certain, from the general evidence, that none could have been taken.

Noxious Animal Food.

Certain kinds of animal food are found to produce, occasionally, symptoms resembling those of irritant poisoning. In some instances this poisonous effect appears to be due to idiosyncrasy; for only one person out of several may be affected. These cases are of importance to the medical jurist, since they may give rise to unfounded charges of criminal poisoning. In the absence of any demonstrable poison, we must test the question of idiosyncrasy by observing whether more than one person is affected, and whether the same kind of food, given to animals, produces symptoms of poisoning. If, with this latter condition, several persons are affected simultaneously, we cannot refer the effects to idiosyncrasy; they are most probably due to the presence of an animal poison. Among the articles of food which have caused symptoms of irritant poisoning, may be mentioned,—

Poisonous Fish. Mussels.—Of all the varieties of shell-fish, none have so frequently given rise to accidents as the common mussel. The symptoms which it produces are uneasiness and sense of weight in the stomach, sensation of numbness in the extremities; heat, dryness, and constriction in the mouth and throat; thirst, shivering, difficulty of breathing, cramps in the legs, swelling and inflammation of the eyelids, with a profuse secretion of tears, and heat and itching of the skin, followed by an eruption resembling nettle-rash. These *symptoms* are sometimes accompanied by colic, vomiting, and purging. They may occur within ten minutes or a quarter of an hour; but their appearance has been delayed for twenty-four hours. There is generally great exhaustion and debility. These symptoms have proceeded from the eating of not more than ten or twelve mussels. Two cases, reported by Christison, proved fatal, the one in three, and the other in about seven hours. In general, however, especially when there is free vomiting, the patients recover. In the inspection of the two fatal cases above mentioned, no appearance was found to account for death. A case in which two mussels produced, in a boy, aged ten, alarming symptoms, followed by an eruption resembling scarlatina and nettle-rash, will be found elsewhere reported ('Guy's Hosp. Reports,' Oct. 1850, p. 213). In July 1860, a number of persons living at Tralee were poisoned under the following circumstances. A woman picked up some mussels which she found at the bottom of the basin of a ship-canal. She distributed them among her neighbours, and during the night twenty-one persons who had eaten them, were attacked with symptoms of poisoning. Three children died, and six persons were placed in imminent peril. The rest were soon out of danger. Eight out of the twenty-one attacked were adults. ('Med. Times and Gazette,' July 28, 1860.) In October 1862, an accident occurred at Liverpool in which a woman died in about four hours, after having

eaten some mussels taken from a ship in the docks. Severe pain and vomiting were among the symptoms, which generally resembled those of arsenical poisoning. Several other persons were made seriously ill, but recovered. Although the vessel was not sheathed with copper or yellow metal, it was coated with a green pigment, of which arsenic may have been a constituent. In four years (1863-7) there were eight deaths from mussels recorded.

The poisonous action of mussels can be referred neither to putrefaction nor disease; nor in all cases to idiosyncrasy, since in one instance those mussels only which had been taken from a particular spot were poisonous; all persons who partook of them suffered, and a dog to which some of them were given, was killed. From a case which occurred to M. Bouchardat, it would appear that copper is sometimes present, and may be the cause of the poisonous effects. Two women were poisoned by mussels, and he found on analysis sufficient copper in the fish to account for the symptoms of irritation from which they suffered. ('Ann. d'Hyg.' 1837, 1, 358.) Copper is not, however, present in all cases, and it is therefore probable that there is in some, if not in all instances, an *animal poison* present in the fish. (See 'Ann. d'Hyg.' 1851, 1, 387; 2, 108.) *Oysters* and *periwinkles* have occasionally given rise to similar symptoms. *Salmon*, sold in the state of pickled salmon, or even *herrings* salted, may also act as irritants: this may be due to the fish being partially decayed before it is used, or to the noxious effects of the pickle. For some remarks by Dr. Hamilton on the poisonous properties of fish, see the 'Pharmaceutical Journal,' January 1853, p. 344.

Cheese.—The symptoms produced by cheese have been those of irritant poisoning. The nature of the poison is unknown. In some cases the irritant property is due to a putrefied state of the curd, or to the production of a rancid irritant oil. Again, it has been supposed that the poison is occasionally derived from certain vegetables on which the cows feed. In 1858 a case was referred to me for examination, in which twenty-five persons had suffered from vomiting and purging, more or less violent, owing to their having partaken of cheese. The only articles of food in common were bread, beer, and cheese. The bread and beer were excluded from any suspicion of containing poison. All the persons recovered. On a close examination of the cheese, I found it to be strongly acid: it had an offensive musty smell, and yielded a quantity of acrid oil to ether. It had not been properly pressed, and the casein had undergone chemical changes. The ashes yielded copper and lead, but only in traces. The cheese had acquired irritant properties, not from the presence of any poisonous matter added to it, but from partial decay. There was abundant evidence that cheese from the same dairy had been eaten without causing any injurious symptoms. This negative evidence, however, is quite consistent with one cheese acquiring noxious properties. We must not lose sight of the fact that cheese may actually contain poison mixed with it through ignorance. Orpiment or chromate of lead may be used as colouring, and the discovery of such mineral substances would at once account for the irritant effects. (See 'Pharmaceutical Journal,' Aug. 1862, p. 89.) The milk and cheese of some of the North American provinces is said to be occasionally rendered poisonous by the fact that cows pasture at certain seasons on vegetables of a noxious kind. In February 1865, twelve cases of poisoning from this cause were reported to the Medico-Chirurgical Society of Edinburgh. The symptoms came on in about three hours after the cheese had been eaten. There was severe pain in the stomach, cramp, violent vomiting of a greenish fluid, soreness of the throat, and a cold clammy condition of the skin. All recovered—recovery being preceded by profuse perspiration. ('Ed. Med. Jour.' 1865, 1, 854.)

Sausage Poison.—The symptoms caused by *sausage-poison* partake of a narcotico-irritant character: they are very slow in appearing—sometimes two,

three, or four days may elapse before they manifest themselves. This poison is of a formidable kind: its effects have been chiefly observed in Germany. In the 'Medical Gazette' for Nov. 1842, there is an account of the cases of three persons, who had died from the effects of liver-sausages, which had been made from an apparently healthy pig, slaughtered only a week before. The inspection threw no light on the cause of death. The poisonous property was supposed to depend on a *partial* decomposition of the fatty part of the sausages. It is said, that when extremely putrefied, they are not poisonous. In a case in which I was consulted, a few slices of a German sausage, evidently of old manufacture, but not putrescent, caused the death of a child, with violent symptoms of irritation of the stomach and bowels. I examined a portion of the sausage: it contained no poisonous matter which admitted of detection. The fatty portions were rancid, and the lean portions very dry. There was no doubt, however, that it had been the cause of the symptoms and death of the child. Dr. Tripe has published a complete account of the effects produced by sausage-poison ('Brit. and For. Med. Rev.' Jan. 1860, p. 197). It appears that in Nov. 1859, sausages made and sold by a pork-butcher at Kingsland, were eaten more or less by sixty-six persons, of whom sixty-four were attacked with violent symptoms of irritation, in from three and a half to thirty-six hours subsequently to the meal. One case only proved fatal, on the seventh day. No symptoms appeared in this man until after the lapse of *six hours*. It seems that he had eaten one of the sausages raw and three cooked. He was attacked with severe vomiting and purging, followed by shivering: there was pain in the abdomen, violent headache, and great prostration. The pulse was feeble and quick, and there was delirium. These symptoms underwent a remission, but he had a relapse, became comatose, and died on the seventh day. Latterly, he chiefly complained of pain in the bowels. Dr. Letheby found, on inspection, no signs of inflammation or of the action of an irritant in the stomach. The small intestines were much inflamed at the lower end, and the gall-bladder was distended. The other organs were healthy. The viscera contained no vegetable or mineral poison. The sausages were made with heifer-beef, pork-fat, sage, and pepper. There was no evidence of anything noxious about them, and a chemical analysis yielded nothing of a poisonous nature. There could, however, be no doubt that the sausages had caused the symptoms and death; the food in this case acting as a narcotico-irritant poison. Other persons suffered from burning in the throat and stomach, followed by vomiting and purging; then giddiness or confusion in the head, and in some there was delirium. In the man who died, the delirium was well marked, and the eyes were red. In those persons who recovered, the noxious animal matter was probably early thrown off by vomiting and purging. (See 'Trichinosis,' p. 343.)

Pork. Bacon.—These common articles of food occasionally give rise to symptoms so closely resembling those of irritant poisoning, as to be easily mistaken for them. In some cases, the effect appears to be due to idiosyncrasy; but in others it can be explained only by supposing the food to have a directly poisonous action. The noxious effects of pork have been particularly shown by the cases published by the late Dr. Mac-Divitt. ('Ed. Med. and Surg. Jour.' Oct. 1836.) As pork is sometimes salted in leaden vessels, lead may be found in it: but fresh pork has been observed to have a noxious action. In January 1864, Mr. Kesteven met with a case in which all the members of a family were attacked with symptoms of irritant poisoning, after eating a leg of pork. The principal symptoms were nausea, vomiting, griping pains in the abdomen, and purging: but dogs and cats fed upon the meat did not appear to suffer. Other portions of the animal from which the leg was taken were eaten by other families, and no symptoms of poisoning were produced. I examined the food without discovering any trace of the ordinary poisons. These

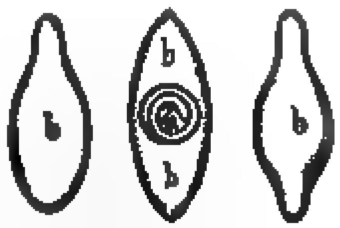
cases of poisoning by animal food have of late been very fully examined by Mr. Simon and Mr. Gamgee. These gentlemen have traced the injurious effects of pork to a diseased condition of the pig, owing to the animal having been fed on improper food. The term measly pork is now very well known to consist in a diseased condition of the flesh of the animal, in which it is filled with a parasite called cysticercus, which is believed to be the larva of the tapeworm. (See 'Med. Times and Gaz.' 1870, 1, 485.) This parasite undergoes full development when in the shape of food it reaches the human intestines. Mr. Gamgee expresses his confidence that there are between 40,000 and 50,000 measly pigs in Ireland, most of which are sent to Great Britain for consumption; and his impression is that for every measly pig in the kingdom there is at least one human being affected with tapeworm. These parasites may not directly kill a person who eats this noxious food, but they favour the development of fatal disease. He also remarks that a microscopical thread-worm, the *trichina spiralis*, brings the muscular flesh of swine into a state in which a small quantity of it eaten raw, or imperfectly cooked, may suffice to injure health or destroy life. In reference to the possible ill effects from consuming, in a well-cooked state, the flesh of animals afflicted with *anthrax* or carbuncular fever, evidence is still imperfect, but he believes that human life may be endangered by it. An opinion has been expressed that boils and perhaps other like affections are caused in human beings by the consumption of diseased meat. According to Mr. Gamgee, at a convict establishment where diseased cattle are eaten in large quantities, and especially cattle afflicted with lung-disease, as many as 40 and 50 cases of boils and carbuncles occur in a month among 1,500 convicts. (Simon's 'Annual Report,' 1863.) This lends support to the theory that diseased animal food is highly favourable to the production of carbuncular disease.

There is reason to believe that, in spite of every precaution, a large amount of diseased and unwholesome meat is sold to the public, and that of the various kinds of flesh used as food none is so subject to disease as pork. Some of the changes which it undergoes are of a microscopical character, and are not likely to be noticed. This subject has attracted the attention, not only of the Board of Health in England, but of the Governments of France and the German States, with a view to the protection of public health. For a full account of the diseases affecting the flesh of the pig, their mode of production, and the prevention of accidents, I must refer the reader to papers by M. Delpech, in the 'Annales D'Hygiène,' 1864, vol. 1, pp. 5, 241 ('De la Ladrerie du porc,' &c.) It has been clearly shown that the parasites found in the flesh of this and other animals are not easily killed by boiling, roasting, or smoking, and that those are liable to suffer the most who habitually eat the raw or partly-cooked flesh. The flesh of the pig containing cysticercus, presents in the cooked state the following appearances. When boiled it is paler than wholesome meat: it appears dryer in patches, and the muscular fibres are more separated than usual. When these are opened, the parasites are seen in the interstices, appearing as opaque white spots of the size of a hemp-seed, and presenting much the same aspect as when living. The caudal bladder attached to their bodies disappears when the meat is thoroughly cooked, and the body of the animal then appears isolated in the middle of the muscular tissue. It is friable and breaks down easily under pressure with a crackling sound, owing to the presence of calcareous matter. In this state it does not appear to be necessarily productive of injury ('Ann d'Hyg.' 1864, 1, 249), although such food must be regarded as most unwholesome. All the members of a family were seized with vomiting, purging, and syncope after having eaten a dish of pork. A medical man examined the meat, and found it full of cysticercus. A pork-butcher was accused of having sold bad meat, but it was proved to have been some cheap pork bought

of a hawker of provisions ('Ann. d'Hyg.' 1864, 1, 246.) If the cysticercus did not cause the symptoms in this case, the meat had undergone some change sufficient to impart to it irritant properties. These parasites occur in all the fleshy parts of the body. I have seen them in the human heart, as well as in the flesh of animals. My colleague, Mr. Hilton, first showed them to me in the living state, in the muscles of the thigh of a man, in 1834. They are not commonly found in the fatty portions of man and animals, and are less common in sheep and oxen than in pigs.

Trichinosis.—The fatal malady arising from the introduction of the trichina spiralis into the human body, has recently attracted much attention in France and Germany; and among others, Dr. Keller of Darmstadt has published some important facts illustrating the symptoms produced, and the mode in which this parasite causes death. Dr. Keller considers that it is a question well worthy of the attention of medical jurists, whether many cases of death from suspected irritant poisoning, in which no poisonous matter could be detected in the body, may not have been really due to trichina disease.

Fig. 41. Fig. 42. Fig. 43.



Magnified view of Trichina spiralis in its capsule.
a. The worm coiled.
b. The capsules.

Fig. 44.

Trichina spiralis in the abdominal muscles of a man: natural size of the capsules containing the worm.

The trichina (from θρίξ, a hair) spiralis, a flesh-worm, is found chiefly in the course of the fibres of all the striped muscles of the trunk and limbs, most frequently on those of the front of the chest, neck, and abdomen. It has also been found in the muscular fibres of the heart and œsophagus or gullet. The parasites appear in the form of very small white ovoid bodies or capsules, perceptible to the eye as white specks, in the midst of the muscular fibres, but only distinctly seen by the aid of a magnifying glass. The trichina or worm is coiled up in the centre of each oval capsule, the greater diameter of which is always parallel to the muscular fibre with which it is closely incorporated. The annexed engraving (fig. 44) is taken from a preparation in the Museum of Guy's Hospital; it represents a portion of the abdominal muscles of a man, covered with trichinæ *in situ*, and as nearly as possible of the natural size. The other illustrations in figs. 41, 42, and 43 are from drawings by Dr. Wilks, representing three of the capsules *b b b* magnified, with the trichina coiled up in the centre of one of them.

These parasites are frequently so numerous as to give to the red flesh a white speckled appearance. According to Dr. Keller, as many as 300,000 have been estimated to exist in half a pound of raw meat: and Dr. Pietra Santa affirms that one gramme (about sixteen grains) of diseased meat may contain 6,000 trichinæ, each having from sixty to eighty embryos. ('Ann. d'Hyg.' 1864, 1, 317.) The actual size of the capsule has been variously stated. From an examination of two sets of specimens in the muscles of the throat and abdomen, I estimated the long diameter to be the 1-50th of an inch, and the short diameter 1-100th. The worm itself varies from 1-20th to 1-30th of an inch in length. The capsules are remarkably uniform in size. They are slowly built up at the expense of the muscular structure by which they are surrounded:

The history of this animal has been given by numerous pathologists. ('Hodgkin's Lectures on Morbid Anatomy,' 1836, 1, 211.) A full description of its anatomy and habits by Dr. Bristowe and Mr. Rainey will be found in the 'Transactions of the Pathological Society' for 1853–4, p. 274. More recent accounts of its influence on health by Dr. Pietra Santa, have been published in the 'Ann. d'Hyg.' 1864, 1, 305 ('La Trichina spiralis'), and by Drs. Schultze and Lücke in Casper's 'Vierteljahrsschrift für gerichtliche Medicin,' 1864, No. 1, p. 103, and No. 2, p. 269. Dr. Lücke's paper is of especial interest, as its title 'Die Trichinen vor dem Forum' implies, since it points to the medico-legal bearings of the subject, and the possible danger of confounding the ravages of this parasite with the obscure effects produced in certain forms of chronic irritant poisoning.

From these researches, it is now clearly established, that the trichina is a viviparous parasite, which passes the greater part of its existence, in the chrysalis state, in the muscular system of animals, until, by the consumption of this muscle as food, it finds in the stomach and intestines of another warm-blooded animal, a favourable medium for its full development into an intestinal worm. According to Virchow and Zenker, the trichina not only frequently presents itself in the human organism, but this organism is most favourable to its development. The period of incubation of the chrysalis in the stomach and bowels of man or of warm-blooded animals, is from six to eight days; and during this time it there thrives and propagates to an almost incredible extent. Dr. Keller states that in three or four days the females produce 100 or more young ones, which begin on the sixth day to leave the parent animal; and he estimates that in a few days after the ingestion of half a pound of meat, the stomach and intestinal canal of a person may contain thirty millions of these minute worms! M. Herbst found the muscles of two dogs which had been fed upon parts of a badger containing worms, to be loaded with these parasites. When once introduced into the stomach and intestines, the worms leave their capsules, become free and produce young which migrate through the walls of the intestines into the muscles: there they become encysted, and are ultimately found appropriating and destroying the muscular substance to a greater or less extent. After a long residence in the muscle they appear to acquire calcareous cysts. The sudden liberation of a large number of these worms causes irritation and inflammation in the bowels, attended by peculiar symptoms resembling in some respects those of chronic poisoning.

It is worthy of note that trichinæ are more frequently found in pork and articles of food derived from it, than in any other kind of meat. Measly pork appears to be sometimes of a trichinous character. Further, the vitality of the parasites is not destroyed unless the meat, or other substances in which they are located, has been subjected to a temperature equal to that of boiling water for a sufficient time to ensure that every particle has been exposed to this degree of heat. Salting and smoking, or partial cooking, is not sufficient to destroy the worms in all parts of the food, and they have even been found living in putrefied meat. This may serve to account in some cases for the serious symptoms which have followed the use of pork as food, also of bacon, sausages, and German sausages, which are generally made of raw ham.

The symptoms produced by the use of such food are, in the first stage, those of intestinal irritation, loss of appetite, sickness, pain, general weakness of the limbs, with diarrhœa, swelling of the eyelids and of the joints, profuse clammy perspiration, and a wasting fever, sometimes of a typhoid character. Death is either the result of paralysis (from destruction of the muscular fibres), or of peritonitis and irritative fever. During the perforation of the coats of the intestines by these worms, the mucous membrane becomes irritated and inflamed: pus is formed on its surface, and bloody evacuations are sometimes

passed. No case is known in which trichinosis, after having once declared itself, was arrested by medical treatment.

The noxious effects of this food on human beings are well illustrated by a series of cases which occurred at Hettstädt in the Hartz Mountains, in 1863. ('British Med. Journal,' Jan. 16, 1864, p. 75.) One hundred and three persons partook of smoked sausages made from a pig affected, as it turned out, with trichinous disease. The sausages were fried, and served for dinner in the usual way. On the following day, several persons who had partaken of this food were attacked with severe pain in the bowels, purging, loss of appetite, great prostration of strength, and fever. The number of persons attacked rapidly increased: symptoms of peritonitis and pneumonia manifested themselves, and these were followed by paralysis of the intercostal muscles, and of the muscles in front of the neck. Eighty-three persons died from the effects of this noxious food, and the remainder were seriously injured in health. The remnants of sausage and of pork not eaten at this festival were examined, and were found to be literally swarming with encysted trichinæ. (See Casper's 'Vierteljahrsschrift,' April 1864, p. 286.) The writer in the above journal affirms that this parasitic disease does not attack sheep, oxen, or horses, and that beef is the safest of all descriptions of food, as no parasites have ever been discovered in it. They have not been found in the blood of animals whose muscles are liable to their attacks.

Dr. Reyber relates that, in the year 1862, a series of cases of illness to the number of thirty occurred in Plauen, as the result of the use of pork containing trichinæ. Among the symptoms were great languor, loss of appetite, fever, and pains in the muscles of the arms and legs. The effects spread like an epidemic. A female patient under Professor Virchow died, at Dresden, with typhoid and rheumatic symptoms. When the body was inspected, trichinæ were found in her muscles. On inquiry, it was ascertained that, four weeks before, a diseased pig had been killed and eaten in the town in which she resided; the butcher who killed it suffered, but this woman alone died from the effects. ('Ann. d'Hyg.' Oct. 1863, p. 471.) Pietra Santa relates that, at a nuptial festival at Wiesbaden, twenty persons partook of the food placed on the table. In the evening the bride was suddenly seized with symptoms of poisoning, and, in spite of medical assistance, died in a few hours. The bridegroom himself suffered from similar symptoms, and died after two days' illness. The other guests were not seriously affected. A physician-expert, who examined the case, found trichinæ in the body of the deceased, as well as in certain articles of food prepared from pork, which had been served at the table ('Ann. d'Hyg.' April 1, 1864, p. 321). The fact that only two out of the party suffered from symptoms resembling poisoning, and that one died rapidly, was calculated to excite grave suspicion. Sudden deaths from trichinous food are not common, and it is to be regretted that this case is not given with fuller details. The real cause of death in these two persons does not appear to have been clearly traced to the trichinous food.

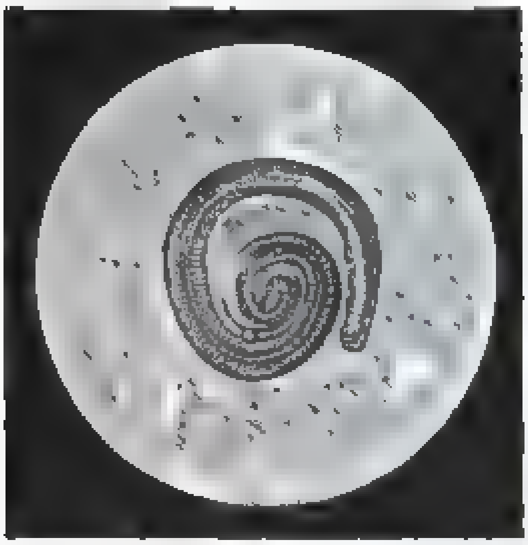
Although little has been heard of trichinous disease in England, it appears to have been prevalent in Germany. Among the official notices published by the Prussian Government, is one which points out the danger arising from the use of pork in a diseased state, and warning those who sell it to the public of the penalties which they thereby incur. (Casper's 'Vierteljahrsschrift,' July 1863, p. 177.) Under this notice, it is stated in addition to the cases above given, that in 1862 thirty-eight persons in Kalbe suffered severely from the use of such food, and of these eight died from the effects.

Dr. Schultze refers to other groups of cases, which, however, do not appear to have been attended with great fatality. In Madgeburg, Neustadt, and Buckau, over a period of five years (1858–62), from three to four hundred cases

of illness were traceable to this cause. ('Die Trichinen Krankheit,' Casper's 'Vierteljahrsschrift,' April 1864, p. 278.) In Burg more than fifty persons suffered, and eleven died. Other fatal cases have been reported. For these I must refer the reader to Dr. Schultze's paper. In February 1864, a whole family was poisoned at New York, and one member died from eating part of a ham, which, on microscopic examination, was found to be full of trichinæ. Death was referred by the medical attendant to this cause. There were two outbreaks of this disease in Massachusetts in 1870. Out of six persons who ate of the noxious food, one died. ('Lancet,' 1871, 1, 515 and 710.) In May 1865, Senator Dittmere of Lubeck and his family, consisting of seven persons, were seized with symptoms resembling irritant poisoning some time after eating a ham which had been smoked but not cooked. On examination it was found to be loaded with trichinæ. Four out of those attacked died. ('Lancet,' May 27, 1865, p. 562.)

It is probable that some unexplained cases of illness or death from irritation of the stomach and bowels, simulating chronic irritant poisoning, may have been the result of eating trichinous food. Medical men have been unable to group the symptoms under any known form of disease, while the marks of irritation in the mucous membrane of the bowels have given strength to the supposition that poison must have been taken by the deceased, although chemical analysis had failed to show the presence of any ordinary poison in the fluids and solids of the body. In the course of many years' practice, I have met with several cases of this description, and there has been sometimes manifested a disposition to doubt the accuracy of chemical analysis. Dr. Lücke has related a series of fatal cases which occurred in 1845, attributed at the time to poison, which, as he suggests, were most probably caused by the use of trichinous food. (Casper's 'Vierteljahrsschrift,' January 1864, p. 102.) As means of distinction from irritant poisoning may be pointed out the long time which commonly elapses between the taking of the food and the commencement of the symptoms. The pain, vomiting, and purging are comparatively slight: the pain is in the bowels rather than in the stomach, and peritonitis, pneumonia, and fever are not commonly results of the action of irritant poisons,

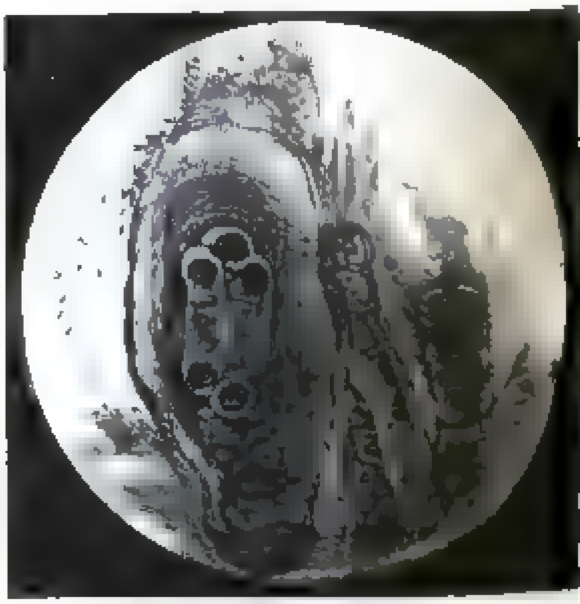
Fig. 45.



Single Trichina spiralis from human muscle, magnified 150 diameters.

This was taken from a case which proved fatal in six weeks. The worm was found to be 1-30th of an inch in length.

Fig. 46.



Trichina spiralis encysted in pork.

This engraving represents the completely encysted worm in horizontal sections, showing six stumps, which proves that the worm lies in these convolutions when it has attained its full size.

while they appear to be constant symptoms in trichinosis. The absence of ordinary poison in the food, in the urine and the evacuations at any stage

may also be taken as conclusive evidence against irritant poisoning in its usual form.

In suspected cases, a new method of research must be added to those already in use. If any of the food can be obtained, this must be examined for the parasite by the aid of the microscope. If the case proves fatal, the voluntary muscles of the deceased must undergo a similar examination. In the 'Canada Medical Journal' for 1870–1, Dr. J. B. Edwards has published a full account of the best methods of detecting trichinæ in the flesh of man and animals. He has furnished me with some excellent photographs of the worms *in situ* in human and animal muscle, of which engravings are annexed.

In some cases which occurred at Montreal the cause of the symptoms was at first obscure, but Dr. Edwards not only found trichinæ in a slice of a ham which had been eaten, but in the muscles of two of the patients who recovered. He removed about five grains of muscular tissue from the gastrocnemius muscle, and twelve grains of the tibialis posticus. In both of these portions of muscle, about forty worms were found. (Op. cit. p. 517. See also Dr. Thudichum's 'Report to Privy Council for 1864–5.') The subjoined engraving (fig. 47) is of great interest. It represents a section of human muscle from one of the fatal cases at Hamilton. Two generations of worms are visible in this muscle, those in the spiral form being a young generation marching past, while the upper curl on the right is the only portion in focus of a large worm, which lies closely curled up and is slightly encysted.

Fig. 47.

Trichina spiralis in human muscle magnified 180 diameters.

Putrescent Food.—The effects of disease on animal food must not be confounded with those which result from decay or putrefaction. The flesh of the most healthy animal is rendered unfit for food when it has passed into a putrescent state. It is not merely unwholesome but highly irritant, causing rapidly vomiting, purging, pain, and other symptoms of a severe kind. Fortunately these symptoms lead at once to the expulsion of the noxious food from the body, and the person then recovers: the young, the old, and the infirm may, however, be so prostrated by vomiting and purging, that they may sink from exhaustion. Animal matter in a state of partial decay, or in the transition stage of putrefaction, must be regarded as of a poisonous nature. Much of the cheap butcher's meat sold to the poor is in a state of decay, and is quite unfit for human food. In one year 114,000 pounds of diseased, and 76,000 pounds of putrid meat were seized and condemned in the City of London alone. In January 1851, the family of a surgeon near London were all affected with symptoms resembling irritant poisoning, after having partaken of a hare which had been stewed in a clean earthen vessel. The surgeon informed me that on the second day his wife was seized with vomiting and purging, giddiness, heat in the throat, and general numbness, with inflamed eyes. Other members of the family vomited, and in the course of a few days the symptoms disappeared. I examined the vomited matter, and found it to consist of portions of the hare partially digested, but in a state of putrefaction, so that there was abundant evidence of sulphuretted hydrogen in the liquid. There was no mineral poison of any kind, although the symptoms, it will be observed, were rather like

those occasioned by arsenic. It had been remarked by the family that a silver spoon, which was used for serving out this unwholesome food, was turned of a brown colour, no doubt from the chemical action of sulphuretted hydrogen; and this may be taken as a good domestic test of the putrefied condition of such food. Nature generally applies an appropriate remedy, in the fact that the food itself produces copious vomiting and purging.

Cases of this kind must be distinguished from those in which *poisoned game* is sold to the public. The game may be quite free from putrefaction, but noxious from the poisoned grain which may have caused death. It is a very common practice to steep grain in a solution of arsenic, previous to sowing, and pheasants, partridges, and other birds may be accidentally destroyed by eating the grain. In some instances, grouse and other game are maliciously destroyed by the laying of corn, saturated with arsenic or other poisons, in the localities where the birds abound. There is no law to prevent the sale of poisoned game by poulterers, and there is no precaution which can be taken by the purchasers, except by observing whether the birds have or have not been shot. (See on this subject, 'On Poisons;' also a letter by Dr. Fuller, 'Med. Gaz.' vol. 42, p. 1036.)

Mr. Taylor, of Romsey, has directed attention (Sept. 1862) to the serious symptoms produced by *Canadian partridges* eaten as food. A lady who had partaken of this food was, in about two hours and a half, attacked with the following symptoms. She had sickness, and became insensible; the skin was cold, and no pulse could be felt. She was in a hopeless state for some hours, and only slowly recovered. The birds were quite fresh, having been packed in ice. In another case there were similar symptoms, with constriction of the throat and great pain. Animals were made ill by this food. It was believed that, in these cases, the birds had not been killed by poison, but that their flesh had been rendered poisonous by some vegetable which they had eaten. It is stated that in some parts of Australia the mutton is rendered poisonous by reason of the sheep feeding on poisonous plants. ('Med. Times and Gaz.' 1871, 1, 728.)

NEUROTIC POISONS.

(NARCOTIC OR CEREBRAL POISONS.)

CHAPTER 26.

OPIUM—SYMPTOMS—APPEARANCES—ITS ACTION ON INFANTS—POISONING BY POPPIES—BY OPIATE COMPOUNDS—MORPHIA AND ITS SALTS—PROCESS FOR DETECTING OPIUM AND ITS PRINCIPAL CONSTITUENTS IN ORGANIC MIXTURES.

Opium.

Symptoms.—The symptoms which manifest themselves when a large dose of opium or its tincture has been taken, are in general of a uniform character. They consist in giddiness, drowsiness, a strong tendency to sleep, stupor, succeeded by perfect insensibility, the person lying motionless, with the eyes closed as if in a sound sleep. In this state he may be easily roused by a loud noise, and made to answer a question; but he speedily relapses into stupor. In a later stage, when coma has supervened with stertorous breathing, it will be difficult, if not impossible, to rouse him. The pulse is at first small, quick,

and irregular, the respiration hurried, and the skin warm and bathed in perspiration, sometimes livid; but when the person becomes comatose, the breathing is slow and stertorous, the pulse slow and full. The skin is occasionally cold and pallid. The pupils in the early stage are contracted; in the later stage, and when progressing to a fatal termination, they may be found dilated. In a case referred to me in 1846, one pupil was contracted and the other dilated. They are commonly insensible to light. The expression of the countenance is placid, pale, and ghastly: the eyes are heavy, and the lips are livid. Sometimes there is vomiting, or even purging; and, if vomiting takes place freely before stupor sets in, there is great hope of recovery. This symptom is chiefly observed when a large dose of opium has been taken; and it may then be, perhaps, ascribed to the mechanical effect of the poison on the stomach. The odour of opium is occasionally perceptible in the breath. Nausea and vomiting, with headache, loss of appetite, and lassitude, often follow on recovery. In cases likely to prove fatal, the muscles of the limbs feel flabby and relaxed, the lower jaw drops, the pulse is feeble and imperceptible, the sphincters are in a state of relaxation, the pupils are unaffected by light, the temperature of the body is low, there is a loud mucous rattle in breathing, and convulsions are sometimes observed before death, but more commonly in children than in adults. One of the marked effects of this poison is to suspend all the secretions except that of the skin. Even during the lethargic state, the skin, although cold, is often copiously bathed in perspiration. It is a question yet to be determined, whether this may not be a medium by which the poison is principally eliminated. The contracted state of the pupils has been hitherto considered to furnish a valuable distinctive sign of poisoning by opium or the salts of morphia. In relying upon it, it is necessary to bear in mind the fact pointed out by Dr. Wilks, that, in apoplexy which is seated in the Pons Varolii, the pupils are also contracted. He describes two cases of this form of apoplexy which were mistaken for poisoning by opium in consequence of this state of the pupils. ('Med. Times and Gaz.' 1833, 1, 214.)

These symptoms usually *commence* in from *half an hour* to *an hour* after the poison has been swallowed. Sometimes they come on in a few minutes, especially in children, and at other times their appearance is protracted for a long period. In a case reported by Dr. Skae, the person was found totally insensible in *fifteen minutes*. As we might expect, from the facts connected with the absorption of poisons, when the drug is taken in the *solid* state, the symptoms are commonly more slow in appearing than when it is *dissolved* in water or alcohol. In a case which occurred at Liverpool, in August 1863, communicated to me by Dr. Edwards, a lady took, on an empty stomach, a large dose (supposed to have been one ounce and a half) of laudanum. No symptoms of narcotic poisoning appeared for four hours and a half, and life was protracted for twenty-two hours.

It has been frequently observed, on these occasions, that a person has recovered from the first symptoms, and has then had a relapse, and died. There is some medico-legal interest connected with this state, which has been called secondary asphyxia from opium, although there appears to be no good reason for giving to it this name. In December 1843, a gentleman swallowed a quantity of laudanum, and was found labouring under the usual symptoms. The greater part of the poison was removed from the stomach by the pump, and he so far recovered from his insensibility as to be able to enter into conversation with his medical attendants; but a relapse took place, and he died the following night. The case of the *Hon. Mrs. Anson* (Jan. 1859) furnishes another illustration of this singular condition. This lady swallowed, while fasting, an ounce and a half of laudanum by mistake. In a quarter of an hour emetics were given, but she did not vomit for half an hour; and she

was not treated medically for two hours and a half. The matter then drawn from the stomach had no smell of laudanum. She was quite unconscious, and had lost the power of swallowing. After remaining in this comatose state for upwards of nine hours, the patient revived, the face became natural, the pulse steady, the power of swallowing returned, she was able to recognize her daughters, and, in a thick voice, to give an account of the mistake she had made. This state lasted about five minutes; the torpor then returned, she again sank into profound coma, and died in fourteen hours after the poison had been taken. It is not improbable that, in these cases, death may be occasioned by the accumulation of the poison, carried by the absorbents into the system; *i.e.* the morphia may be more rapidly carried into the system than it is eliminated from it. A remarkable case illustrative of this *remittent* form of poisoning by opium has been published by Mr. Kirby. ('Dublin Med. Press,' Dec. 24, 1845, p. 406.) In compound poisoning, where laudanum is one of the ingredients, it may be expected that symptoms of narcotic poisoning will first show themselves. In a case which occurred to Mr. Beatty, a woman, æt. 22, swallowed a packet of Battle's Vermin Killer. and immediately afterwards two drachms of laudanum, and then half a drachm of red precipitate. In three hours she was found to be suffering from narcotic poisoning alone. None of the effects of strychnia had been produced, and there was no irritation from the mercurial poison. Emetics were given, and the stomach-pump used. By this a quantity of Battle's powder and red precipitate were removed from the stomach. Albumen was given, and the woman slowly recovered. ('Lancet,' 1871, 2, 907.) It was inferred that the opium had here prevented the action of strychnia. It would have been more satisfactory if the powder drawn from the stomach had been examined and strychnia found in it. There were no symptoms of poisoning by strychnia at any time, although three hours had elapsed before remedies could be applied.

Appearances.—In a case which proved fatal in fifteen hours, the vessels of the head were found unusually congested throughout. On the surface of the fore part of the left hemisphere there was an ecchymosis, apparently produced by the effusion of a few drops of blood. There were numerous bloody points on the cut surface of the brain:—there was no serum collected in the ventricles. The stomach was quite healthy. Fluidity of the blood is mentioned as a common appearance in cases of poisoning by opium. There is also engorgement of the lungs: most frequently observed, according to Sir R. Christison, in those cases which have been preceded by convulsions. (Op. cit. p. 732.) Among the external appearances there is often great lividity of the skin. Extravasation of blood on the brain is rarely seen;—serous effusions in the ventricles, or between the membranes, are sometimes met with. The stomach is so seldom found otherwise than in a healthy state, that the inflammatory redness said to have been occasionally seen may have been due to accidental causes. When tincture of opium has been taken and retained on the stomach, increased redness of the mucous membrane may occasionally be produced by the alcohol alone. In a case of poisoning by a large dose of tincture of opium, Dr. Sharkey found the following appearances twelve hours after death: the body warm and rigid; the stomach healthy, containing a quantity of gruel-like fluid, without any smell of opium. The intestinal canal and all the other viscera were healthy. The veins of the scalp, as well as of the dura mater and sinuses, were gorged with blood; but there was no effusion in any part of the brain. The contents of the stomach yielded no trace of morphia or meconic acid, but there was no doubt that death had been caused by opium, taken on the previous night. ('Med. Gaz.' vol. 37, p. 235.) A case was communicated to me by Dr. Ogston, which was the subject of a trial at the Aberdeen Autumn Circuit, in Sept. 1853, in which a child, aged six months,

died in a few hours from a dose of sixty drops of wine of opium. The brain was congested to a marked extent. Although the dose was comparatively large, and death rapid, there was no decided indication of the presence of opium in the stomach. From this account of the appearances in the dead body, it will be seen that there is nothing but a fulness of the vessels of the brain, which can be looked upon as specially indicative of poisoning by opium, and even this is not always present. A congested condition of the brain, however, if it exist, can furnish no evidence of poisoning when taken alone, since it is so frequently found, as a result of morbid causes, in otherwise healthy subjects.

Quantity required to destroy life.—The medicinal *dose* of opium, in *extract* or *powder* for a healthy adult, varies from half a grain to two grains. Five grains would be a poisonous dose to most persons. The medicinal dose of the *tincture* is from ten minims to forty. One fluid ounce of tincture of opium (laudanum) contains the soluble matter of thirty-three grains of opium. This is in about the proportion of fourteen and a half minims of the tincture to one grain of dry opium. (Garrod.) The *smallest dose of solid opium* which has been known to prove fatal to an adult, was in a case reported by Dr. Sharkey, of Jersey. A man, æt. 32, died very speedily in a convulsive fit, after having taken two pills, each containing about one grain and a quarter of extract of opium. This quantity is equivalent to *four grains* of crude opium. ('Med. Gaz.' vol. 37, p. 236.) The *smallest fatal dose of the tincture* in an adult, which I have found recorded, is *two drachms*. The case is reported by Dr. Skae. ('Ed. Med. and Surg. Journ.' July 1840.) The patient was a robust man, æt. 56; he swallowed the tincture at ten in the evening, and died under the usual symptoms on the following morning, the case having lasted only twelve hours. The quantity actually swallowed, however, appears to be involved in some doubt; for it is subsequently stated that *half an ounce* of laudanum may have been taken. In another case, May 1870, a lady died from a dose of two drachms of laudanum mixed, it was supposed, with chloroform. Large doses of the tincture have frequently been taken without proving fatal. I have elsewhere recorded a case in which five ounces of laudanum were taken even without producing sleep, and the patient recovered. ('Guy's Hosp. Reports,' Oct. 1850, p. 220.) One hundred and fourteen deaths from opium are reported to have occurred in four years—1863–7.

Action of Opium on Infants.—In connection with this subject, it is important for a medical jurist to bear in mind that *infants* and young persons are liable to be killed by small doses of opium; they appear to be peculiarly susceptible of the effects of this poison. Dr. Ramisch, of Prague, met with an instance of a child, four months old, that was nearly killed by the administration of one grain of Dover's powder, containing only the tenth part of a grain of opium;—the child suffered from stupor and other alarming symptoms. The following case occurred in June 1822. Four grains of Dover's powder (containing less than half a grain of opium) were given to a child four years and a half old. It soon became comatose, and died in seven hours. Death was referred to inflammation of the throat, and the jury returned the usual unmeaning verdict of 'Died by the visitation of God;' but there was no doubt, from the evidence, that death was caused by the opiate medicine. Dr. Thorn, of the Cape of Good Hope, has given me the particulars of a case of an infant only three days old, to which ten grains of Dover's powder (containing one grain of opium) were given by mistake. It suffered from the usual symptoms, but survived for the long period of forty-four hours. Dr. Kelso met with an instance in which a child, nine months old, was killed in nine hours by four drops (? minims) of laudanum, equal to less than *one-fourth part of a grain* of opium; it was much convulsed before death. A case is referred to in the 'Medical Gazette,' in which two drops (? minims) of laudanum, equal to about the *eighth*

part of a grain of opium, killed an infant. The following is another illustration of the fatal effects of a similar dose. A nurse gave to an infant, five days old, *two drops* (? minims) of laudanum, about three o'clock in the morning. Five hours afterwards the child was found by the medical attendant in a state of complete narcotism. It was revived by a cold bath, but a relapse came on, and it died the same evening, about eighteen hours after the poison had been given to it. On inspection, the brain and abdominal viscera were found in a perfectly healthy state, and there was no smell of opium in the stomach. ('Prov. Med. Jour.' Oct. 28, 1846, p. 519.) The fatal dose here, as in the former case, was equal to the eighth part of a grain of opium, and to only an infinitesimal dose of morphia! Dr. E. Smith has reported a case ('Lancet,' April 15, 1854), in which an infant, *seven days* old, died in eighteen hours from the effects of one *minim* of the tincture, or the *fifteenth part of a grain* of opium. Coma with the usual symptoms was complete in half an hour. On inspection, the heart was found distended with black liquid blood: the lungs were collapsed but not congested. The brain was congested, but there was no effusion either into the ventricles or on the surface. (See also 'Med. Times and Gazette,' April 15, 1854, p. 386.) The smallest fatal dose recorded (in an infant) was in a case communicated to me by Dr. Edwards of Liverpool (November 1857). An infant, four weeks old, died from the symptoms of poisoning by opium, in seven hours after a dose of paregoric elixir, equivalent to *one-ninetieth* of a grain of opium, had been administered to it. With a knowledge of these facts, it is not surprising that infants are occasionally destroyed by opium under circumstances in which an adult would not suffer. In December 1860, an inquiry took place at Chester respecting the death of a child, aged six weeks, under the following circumstances. A fomentation composed of laudanum and gin was applied to the side of the mother, and the child was put to the breast shortly afterwards. The child fell into a sleep from which it did not awaken, and died, in spite of treatment, the next morning. The cause of death was left obscure owing to the imperfect manner in which the inquiry was conducted: but it is not improbable that the child drew a quantity of laudanum into its mouth, sufficient to destroy life. ('Med. Times and Gaz.' Jan. 19, 1861, p. 70.) In some instances infants have been found to manifest an astonishing power of recovery. Dr. Guy met with a case in which an infant of six months recovered after having had administered to it ten grains of Dover's powder, equal to one grain of opium ('Lancet,' June 8, 1850); and Mr. Tubbs has informed me, that in a case which occurred in January 1852, an infant of nine months recovered under treatment from a dose of two teaspoonfuls of laudanum, given by mistake. This quantity left by evaporation four grains of an impure extract of opium. In 1860 a case was communicated to me in which an infant of between two and three months old recovered after *five grains* of opium had been given to it by mistake for rhubarb. Dr. Hays met with a case in which a child, not quite six years old, swallowed a powder containing *seven and a half grains* of opium mixed with powdered chalk. The child was not seen until fourteen hours afterwards. It was at first excited: there had been no vomiting. The narcotism was at no time very profound: it gradually subsided, and at the end of three days the child had recovered! ('Am. Jour. Med. Sci.' April 1859, p. 367.) According to a return of the number of deaths from poison in four years (1863–7), there were 426 cases of poisoning by laudanum, syrup of poppies, and similar preparations, among infants.

Period at which death takes place.—It has been remarked that most cases of poisoning by opium prove fatal in from about six to twelve hours. They who recover from the stupor, and survive longer than this period, generally do well; but from cases above related it would seem that there may be a partial

recovery, or a remission of the symptoms, and afterwards a relapse. The symptoms, however, generally progress steadily to a fatal termination, or the stupor suddenly disappears, vomiting ensues, and the person recovers. Several instances are recorded of this poison having destroyed life in from seven to nine hours. One has occurred within my knowledge, in which an adult died in five hours after taking the drug prescribed for him by a quack. Sir R. Christison met with a case which could not have lasted above five, and another is mentioned by him which lasted only three hours. Mr. Barwis, of Melton, communicated to me the case of an adult (November 1863) which proved fatal in three hours and a half. Nearly two ounces of laudanum had been taken; but there was no smell of opium in the stomach when inspected thirty hours after death. Dr. Beck quotes a case which proved fatal in two hours and a half. (Beck, 'Med. Jour.' p. 873.) Mr. Procter, of York, communicated to me the case of a female, æt. 50, who, in January 1857, swallowed an ounce of the pharmacopœial tincture, and died from the effects in less than *two hours.* Opium was found in the stomach. The only appearance in the body was a congested state of the membranes of the brain. The most rapid case of death yet reported was that of a soldier who was accidentally poisoned, in September, 1846, in the Hospital of Val-de-Grâce. It appears that he swallowed by mistake about an ounce of laudanum, and it is stated that he died in convulsions in *three quarters of an hour.* ('Journal de Médecine,' Oct. 1846, p. 475. For a similar case, see 'Med. Gaz.' vol. 45, p. 743.) It is possible that the drug may destroy life even with greater rapidity than this; but, as a medico-legal fact, we are at present entitled to state that it has destroyed life within the short period above mentioned. On the other hand, the cases are sometimes much protracted. There are several instances of death in fifteen or seventeen hours. I have known one case fatal in twenty-two hours, and among those collected by Sir R. Christison, the longest lasted twenty-four hours. (Op. cit. 712.)

Poisoning by Poppies.

The heads of the white poppy grown in this country possess narcotic properties. They yield an inspissated extract called English opium, which, according to Mr. Hennell, contains 5 per cent. of morphia. The white poppy-heads, therefore, yield to water, in the form of decoction, a poisonous substance capable of acting deleteriously on children. In July 1863, a child died at Bilston, in consequence of its mother having administered to it two spoonfuls of water in which a poppy-head had been boiled. ('Med. Times and Gaz.' July 18, 1863, p. 75.) Many cases of poisoning have occurred from the injudicious use of *Syrup of poppies*, which is nothing more than a sweetened decoction of the poppy-heads. This syrup is said to contain *one grain* of extract (opium) to one ounce (Thomson). The common dose of it, for an infant three or four months old, is half a drachm; for adults, two to four drachms. ('Pereira,' vol. 2, pt. 2, p. 643.) There is some reason to believe that what is often sold by many druggists under the name of syrup of poppies as a soothing or cordial medicine for children, is nothing more than a mixture of tincture or infusion of opium with simple syrup: it is therefore a preparation of variable strength. This may account for what appears to many persons inexplicable, namely, that an infant may be destroyed by a very small dose. In January 1841, a child six months old is said to have died from the effects of less than half a teaspoonful of syrup of poppies bought at a druggist's. This is the usual medicinal dose for a child. The symptoms of narcotic poisoning were fully developed in three-quarters of an hour. The syrup in this case probably contained tincture of opium. Several children are reported to have lost their lives by this syrup in 1837–8. In one of these instances, a teaspoonful and a half was given. Stupor

came on in half an hour, and the child died the following day. Dr. Pereira mentions a case in which a teaspoonful proved fatal to a healthy child. I have notes of two cases which occurred in 1871, in one of which a child eighteen weeks old died in twenty-six hours from the effects of a teaspoonful, and the other in which an infant five weeks old was killed by three parts of a teaspoonful of this syrup. It is in all cases a most uncertain preparation as to strength.

Mrs. Winslow's 'Soothing Syrup,' called also 'Quietness,' appears to be a compound resembling syrup of poppies. Its effects are those of a narcotic. Two doses of this caused the death of a child aged fifteen months, with the usual symptoms of narcotic poisoning ('Pharm. Jour.' 1872, 618). An analysis of this syrup showed that one ounce of it contained nearly one grain of morphia with other opium alkaloids ('Pharm. Jour.' June 1872, p. 975). It is not surprising that it should prove fatal to infants in small doses.

Godfrey's Cordial.

This is chiefly a mixture of infusion of sassafras, treacle, and tincture of opium. The quantity of tincture of opium contained in it is stated by the late Dr. Paris to be one drachm in six ounces of the mixture, or *half a grain of opium to one ounce*: but it is probable that, like the so-called syrup of poppies, its strength is subject to variation. A case has been reported, in which half a teaspoonful, = 1-32nd part of a grain of opium, was alleged to have caused the death of an infant. In 1837–8, twelve children were reported to have been killed by this mixture alone, and in four years (1863–7) fifty-six deaths were recorded to have taken place from this compound. The explanation of this great mortality is, that the medicine is usually given in large doses by ignorant persons.

Dalby's Carminative.

This is a compound of several essential oils and aromatic tinctures in peppermint water, with carbonate of magnesia and tincture of opium. According to the late Dr. Paris there are *five minims* of the tincture, or one-third of a grain of opium, in rather more than two ounces of this mixture, or *the one-sixth of a grain in an ounce*. The formula commonly given is—carbonate of magnesia two scruples, oil of peppermint one minim, of nutmegs two minims, of aniseed three minims, tincture of opium five minims, spirit of pennyroyal and tincture of assafœtida, of each fifteen minims, tincture of castor and compound tincture of cardamoms, of each thirty minims, and of peppermint water two ounces. According to this formula, tincture of opium forms the 1-211th part by measure, or one teaspoonful contains the 1-64th part of a grain of opium. Like most of these quack-preparations, it varies in strength. An infant is reported to have been destroyed by *forty drops* of this nostrum, a quantity, according to the strength assigned, equivalent to more than *two minims* of the tincture, or about one-eighth of a grain of opium. Accidents frequently occur from its use, partly owing to ignorance, and partly to gross carelessness on the part of mothers and nurses.

The quack medicine, known under the name of *Locock's pulmonic wafers*, contains opium. A boy, æt. 4, suffered from all the usual symptoms of poisoning by opium as a result of eating a quantity of these wafers or lozenges, ('Lancet,' Oct. 27, 1860, p. 420.)

Paregoric Elixir. (Camphorated Tincture of Opium.)

This is a medicinal preparation of alcohol, opium, benzoic acid, oil of anise and camphor. Opium is the active ingredient, and of this the tincture contains *one grain* in every *half-ounce*. In one case of poisoning by this tincture,

a child, aged seven months, died from the effects of a teaspoonful (equal to one quarter of a grain of opium) given in two doses at an interval of a day. ('Pharmaceutical Journal,' April 1845.) In another, an infant of five weeks recovered from a similar dose, although no treatment was resorted to for nine hours. ('Med. Times and Gaz.' Aug. 6, 1859, p. 145.) An infant has been killed by a dose equivalent to not more than the *ninetieth* part of a grain of opium.

The *ammoniated tincture of opium* is compounded of opium, saffron, benzoic acid, oil of anise, strong solution of ammonia, and rectified spirit. It contains one grain of opium in ninety-six minims, and the medicinal dose is from half a drachm to one drachm.

Dover's Powder. (Powder of Ipecacuan and Opium.)

This is a preparation of opium, the effects of which on infants and children have been already described (p. 352). The proportion of opium is one-tenth part, or *one grain* in every *ten grains* of the powder. A child has been killed by four grains; therefore by a quantity containing about two-fifths of a grain of opium. Dr. Brown, of Lahore, relates the case of a child at fourteen months, who took by mistake six grains of Dover's powder—equivalent to six-tenths of a grain of opium—at six o'clock, P.M. In a quarter of an hour he felt drowsy and fell asleep; at two o'clock, A.M., eight hours after taking the poison, he had severe convulsions; his pupils were dilated, and his pulse was slow and irregular. He remained insensible, and died at three, A.M., nine hours after taking the powder. (On 'Poisons in the Punjab,' 1863, p. 71.) On the other hand, Mr. Ewens met with a case in which an infant of nine months recovered from a dose of five grains. ('Med. Times and Gaz.' May 19, 1860.) Dr. Guy has reported another, in which an infant of six months recovered, under active treatment, from a dose of ten grains. ('Lancet,' June 8, 1850.) I am indebted for a still more remarkable instance of recovery to Mr. R. Read, of Dublin. Fifteen grains of Dover's powder were given to an infant under five months of age. The mistake was discovered immediately, and by active treatment the child recovered. These cases of recovery in infants must be regarded as exceptional.

Black Drop.

This is a preparation of opium, in which the morphia is combined with acetic acid, and very little meconic acid is present. In the Black drop, according to Pereira ('Mat. Med.' vol. 2, Pt. 2, p. 650), verjuice, the juice of the wild crab, is employed as a solvent instead of vinegar. The Black drop is considered to have from three to four times the strength of the tincture of opium. The formula for this preparation will be found in Dr. Neligan's work, 'On Medicines,' &c., p. 235. According to this, it is a compound of half a pound of opium to three pints of the expressed juice of the wild crab. It resembles the *Acetum Opii*, and has more than twice the strength of laudanum.

Sedative Solution (Battley's).

This is an aqueous solution of opium holding a little spirit and less meconic acid than the common tincture. ('Pereira,' vol. 2, Pt. 2, p. 646.) It is considered to have three times the strength of tincture of opium; but there is so great a difference of opinion on this point, that Dr. Neligan represents it as being only of about the same strength. ('Medicines,' &c., p. 236.) He states that it is composed of three ounces of extract of opium, six drachms of spirit, and as much distilled water as will make up two pints. It appears to be in some cases an energetic preparation. Mr. Streeter stated at the Westminster

Medical Society, Dec. 1838, that he had known one drachm and a half of it prove fatal to a lunatic, and twenty minims of the solution destroyed the life of an old woman. A medical gentleman, lying dangerously ill from an attack of dysentery, took, by mistake, about seven drachms of Battley's solution. Within five minutes, salt and water with mustard were administered, and twenty-four grains of sulphate of zinc. Vomiting ensued; the emetic was repeated, and with the same effect, the fluid evacuated at the second vomiting having the usual smell of opium. Half a drachm of ipecacuanha was subsequently given to complete the emptying of the stomach. Notwithstanding repeated vomiting, symptoms of narcotism presented themselves speedily, with contraction of the pupils, and great drowsiness—rendering it necessary to remove the patient from bed in his debilitated state, and keep him constantly moving, until about nine P.M. (seventeen hours), when vomiting came on spontaneously, and he was put to bed and allowed to sleep. The original disease afterwards resumed its course (complicated by an attack of gastritis), and at length terminated favourably; but the patient had no recollection of what had occurred for twenty-four hours after the administration of the emetics; and it appeared to his medical attendants that an excited state of mind remained for some days afterwards. ('Prov. Journ.' Jan. 28, 1846, p. 42.) The death of Dr. Baddeley, of Chelmsford, from a dose of this medicine, furnishes an additional proof of the dangerous uncertainty of its strength.

CHLORODYNE.

A fatal case from an overdose of this medicine occurred at Oxford in 1871. A lady, æt. 23, had been accustomed to take the liquid for the relief of pain, in doses of as much as sixty drops. She was found dead in bed, and the cause of death was referred by her medical attendant to her having taken two doses without letting a sufficient interval elapse between them. ('Lancet,' 1871, 2, 697.) From 1863 to 1867 four deaths were caused by this compound. According to Mr. E. Smith chlorodyne is thus constituted:—Chloroform four drachms, muriate of morphia twenty grains, rectified ether two drachms, oil of peppermint eight minims, prussic acid six drachms, mixture of gum acacia one ounce, treacle four ounces. ('Lancet,' 1870, 1, 72.) There is reason to believe that this compound is not uniform in composition. According to another formula the tinctures of lobelia and capsicum with extract of liquorice, are introduced. One sample, on standing, separated into two liquids, one light and of a pale straw colour, and the other heavy and of a brown colour and syrupy consistency. On evaporation it left half of its weight of solid residue as saccharine matter. Another sample remained in a thick syrupy state. A fluid-drachm of the first sample left as a residue twenty-seven grains of a brown saccharine extract. Prussic acid may be detected in it by the reaction of the vapour on nitrate of silver. Crystals of cyanide of silver are obtained after some time. Morphia may be detected in it by shaking a portion with a mixture of sulphide of carbon and iodic acid. The sulphide acquires a pink colour, owing to the separation of iodine by the morphia. The other substances may be detected in it by their appropriate tests.

NEPENTHE.

In a case tried at the Chester Assizes, the nature of the compound sold under the above name was a subject of inquiry. It is a pale sherry-coloured liquid, of a spirituous odour, with the smell of opium, and an acid reaction. It contains 3·4 per cent. of solid matter, consisting chiefly of a purified extract of opium with a small quantity of sugar. It also contains a trace of tannic acid, which causes a darkening of the liquid when a persalt of iron is added to it for the detection of meconic acid. This disappears, and the red colour

of meconate of iron is brought out when a small quantity of diluted sulphuric acid is added to it. Morphia is readily detected in it by a mixture of iodic acid and sulphide of carbon. The sulphide acquires a pink-red colour. It may be regarded as a purified alcoholic solution of meconate of morphia, with a little excess of acid, and of about the same strength as laudanum. It has a similar mode of action. A very small quantity has sufficed to destroy the life of an infant. An infant fourteen days old died under the following circumstances. Some dill-water was procured at a druggist's, and it was put into a bottle which had contained nepenthe. A teaspoonful was given to the infant. It soon fell asleep, and died in a short time under all the symptoms of narcotic poisoning. The dill-water was slightly coloured from the small quantity of opiate dissolved. ('Pharm. Journ.' 1872, p. 779.)

MORPHIA AND ITS SALTS.

Morphia is the poisonous alkaloid of opium, of which it forms from five to ten per cent. The two principal salts of this alkaloid are the HYDROCHLORATE and the ACETATE. In four years (1863–7) there were thirty-two deaths from morphia in England and Wales.

Symptoms.—The symptoms generally *commence* in from *five* to *twenty minutes* after the dose of poison (in solution) has been swallowed; and they closely resemble those observed in poisoning by opium. As a summary, it may be stated that they consist in dimness of sight, weakness and relaxation of the muscular system, the face and hands congested and of a livid or bluish colour, a strong tendency to sleep, stupor, loss of consciousness, coma, stertorous respiration, and, more commonly than in poisoning by opium, there are convulsions. According to Orfila, in nineteen-twentieths of all cases the pupils will be found strongly contracted, a statement which I believe to be correct: the few exceptional cases were those in which the dose was excessive, and the symptoms were unusually violent. The state of the pupils gave rise to a great difference of opinion among the medical witnesses on the trial of Dr. Castaing. ('ON POISONS,' 2nd ed. p. 619.) The condition of the pulse varies greatly. It has been found small and feeble, sometimes full and slow. In some cases there is great irritability, as well as itching of the skin, and irritability of the bladder with difficulty of passing urine. Vomiting and purging have been met with in those instances in which the dose was large.

It has been stated that morphia in large doses does not operate as a narcotic, but as a stimulant to the nervous centres, causing violent convulsions. In some instances the convulsions are said to have assumed a tetanic character, resembling those caused by strychnia. This is stated to have been noticed where the alkaloid or its salts had been used hypodermically. The statement appears to be based more upon theory than fact. I know of no cases to support the theory, but many adverse to it. Such theoretical views become of serious import to medical evidence, when it is pretended that the tetanic symptoms of strychnia are not to be distinguished from those caused by large doses of morphia. They just serve the purpose of unsettling everything and settling nothing. One medical authority has announced that all the symptoms assigned to poisoning by strychnia in Cook's case (*Reg.* v. *Palmer*) might be explained by supposing that he had taken three grains of morphia! In this case there were no symptoms of any kind for three-quarters of an hour after deceased had taken two pills which were given to him by the prisoner. Tetanic symptoms of a violent kind with opisthotonos then came on suddenly; there was no loss of consciousness, and death occurred in twenty minutes. If this was poisoning by morphia, then medical experience and observation go for nothing in reference to poisoning by strychnia. We must wait for well ascertained facts before accepting this theory.

Poisoning by morphia may take place as the result of external application. I am indebted to a friend for a remarkable illustration of its fatal effects by absorption. In September 1867, a woman, suffering from cancer of the breast in a state of ulceration, applied to a druggist at Bungay for some medicine to relieve pain. He applied at once *thirty grains* of morphia, covering with it the surface of the ulcer. The woman soon afterwards became insensible. When seen by a medical man she was quite unconscious—the pupils were contracted, the skin very cold, the pulse full and compressible. The woman was then in a hopeless state, and she died in ten hours after the application of the morphia to the breast. The druggist, when examined at the inquest, said that in his judgment the application was right and proper, and in spite of medical evidence that the symptoms and death were referable to morphia by absorption, the jury returned a verdict of death from natural causes!

Fatal Dose.—Four cases are recorded in which a dose of *one grain* of hydrochlorate of morphia has proved fatal to adults: in one it was taken in solution; in a second in a pill; in a third in a powder; and in a fourth it was administered by hypodermic injection into the tissue under the skin of the forearm. The first of the cases occurred to Dr. Paterson in December 1845. ('Ed. Monthly Journal,' Sept. 1845, p. 195.) The morphia was taken in divided doses, in six hours. The symptoms and appearances were of the usual character, and insensibility came on rapidly. The patient died in about seven hours. The second case occurred at St. Mary's Hospital, May 1861: a man, æt. 45, died in thirteen hours from a dose of one grain of hydrochlorate of morphia, prescribed in a pill by one of the physicians. The symptoms came on in about three hours, and were of a well-marked character. No morphia was detected in the stomach or other organs, and its operation as a poison was ascribed, without any apparent ground, to disease of the kidneys. In the third case (March 1863) I was consulted by Mr. Charsley, Coroner for Bucks. A healthy man, æt. 52, died in about ten hours from the effects of *one grain*. Three hours after taking the powder, he lost his senses of smelling and hearing, and passed rapidly into a comatose condition, from which he did not recover (case of *Cordery*, Burnham, March 1863). The practitioner who prescribed the morphia alleged that he had given only half a grain, but the facts of the case were adverse to this statement. On analysis I could detect no morphia in the stomach. The fourth case occurred at the Middlesex Hospital, in May 1863. I am indebted for the particulars to Mr. De Morgan, under whose care the patient was placed. One-third of a grain of morphia was injected at night under the skin: in two hours the injection of a similar quantity was repeated. On the next morning another third of a grain was injected. The man slept quietly for two hours. He then took some dinner, and talked in his usual way; but in another hour he became almost suddenly insensible, and in two hours he died, the narcotic symptoms being most powerfully developed. Dr. Anstey met with a case in which three grains of morphia given as an injection per rectum caused death in sixteen hours.

The hydrochlorate is thus proved to be a powerful poison in a small dose: it may operate either suddenly or slowly, and destroy life rapidly. An infant has died from a dose of one-twelfth part of a grain. ('Chem. News,' Aug. 22, 1863, p. 98.) Sir R. Christison considers that one grain of the hydrochlorate is fully equal in power to six grains of the best Turkey opium. There is no reason to suppose that the acetate is less potent: but there are some remarkable instances of recovery where such a result could scarcely have been anticipated. In the 'Lancet,' for 1863, vol. 1, p. 8, is reported the case of a child about two years of age, who recovered from a dose of one grain of the acetate. The medicinal dose for an adult of either of these salts of morphia is from one-eighth of a grain to one-half grain. A case in which *one grain* of

the acetate, dispensed by mistake in a pill, destroyed the life of a lady, is reported. ('Pharm. Jour.' July 1872, p. 16.) Narcotic symptoms came on in about half-an-hour, and she died in nine hours.

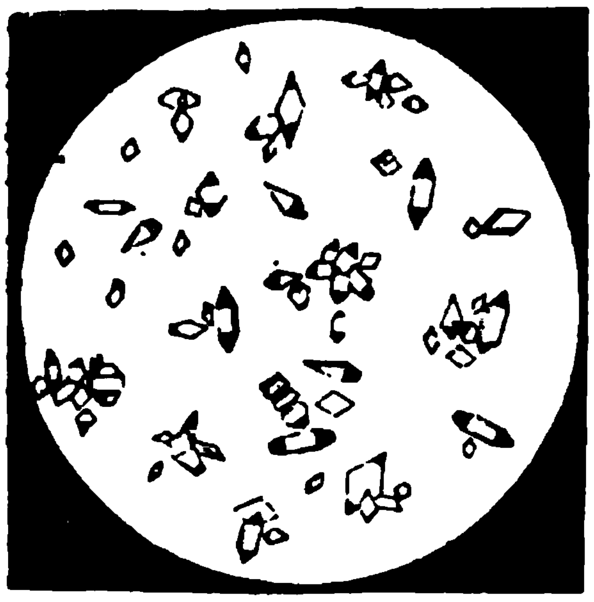
Appearances.—The only post-mortem appearance which can be referred to the action of morphia is fulness of the cerebral vessels, with occasionally serous effusion and bloody points on a section of the brain substance. This poison has no local irritant action, and it therefore leaves no marks of its operation in the stomach and bowels. An account of the appearances produced by an overdose of sulphate of morphia has been published by Orfila in a report of the case of *Dr. Ellenberger* ('Ann d'Hyg.' 1852, 2, 359). The case presents some curious features. The deceased imagined that he had discovered a certain antidote for morphia and its salts, and proposed, while Orfila was at Prague in October 1851, to swallow the poison and the antidote in his presence. Orfila consented to witness the experiment. A powder was produced, which was found to have a bitter taste, and to possess some of the chemical properties of morphia, evidently mixed, however, with some other substance. The doctor swallowed about twenty-three grains of this powder, and immediately afterwards his so-called antidote, which was a fine white powder having a sweetish taste. He did not suffer from any symptoms of poisoning. Orfila, with a keen eye to the practical use of antidotes, inquired whether he had ever allowed a certain interval to pass before taking the remedy. Dr. Ellenberger said that the results were the same. Six months after this experiment, Dr. Ellenberger died from a dose of about ten grains of sulphate of morphia. He had taken his antidote, but not until a considerable interval had elapsed. A minute inspection of the body was made, and the principal appearance was a well-marked congestion of the brain and its membranes. There were traces of sulphate of morphia in the stomach. The so-called antidote was examined, and found to consist of a mixture of magnesia and carbonate of magnesia!

Chemical Analysis.—Opium.—There are no means of detecting opium itself, either in its solid or liquid state, except by its smell and other physical properties, or by giving a portion of the suspected substance to animals, and observing whether any narcotic effects are produced. The smell is said to be peculiar, but a similar smell is possessed by lactucarium, which contains neither meconic acid nor morphia. The *odour* is a good concomitant test of the presence of the drug, whether it be in a free state or dissolved in alcohol or water, but it is not perceptible when the solution is much diluted. I found that half a grain of powdered opium, dissolved in half an ounce of water, lost its characteristic smell by a short exposure. The odour is decidedly volatile, and passes off when an opiate liquid is heated; it also escapes slowly at common temperatures. Again, it may be easily concealed by other odours, or the drug may undergo some change in the stomach during life which may rapidly destroy the odour. (Case by Mr. Barwis, p. 353.) The analysis in cases of poisoning by opium is therefore limited to the detection of morphia and the acid with which it is combined, meconic acid.

Morphia.—Morphia may be identified by the following properties:—1. It crystallizes in fine prisms, which are white and perfect, according to their degree of purity. These crystals may be obtained by adding weak ammonia to a solution of morphia in hydrochloric acid. (See fig. 48.) 2. When heated on platinum, the crystals melt, become dark-coloured, and burn like a resin with a yellow smoky flame, leaving a carbonaceous residue. If this experiment is performed in a small reduction-tube, it will be found, by employing test-paper, that ammonia is one of the products of decomposition. 3. It is scarcely soluble in cold water, as it requires 1000 parts to dissolve it: it is soluble in 100 parts of boiling water, and the hot solution has a faint alka-

line reaction. By its insolubility in water, it is readily known from its salts. It is not very soluble in ether, thus differing from narcotina; but it is dissolved by forty parts of cold water, and rather less than this quantity of boiling alcohol. It is dissolved by a solution of potash or soda, from which it cannot be removed by ether. It is very soluble in acetic ether, and this has been employed as a substitute for ether in procuring morphia from organic liquids. 4. It is easily dissolved by a very small quantity of all diluted acids, mineral and vegetable. 5. Morphia and its solutions have a bitter taste. 6. The salts of morphia are not precipitated in a crystalline form by solutions of sulphocyanide of potassium, ferrocyanide of potassium, or chromate of potash. In this respect they are strikingly distinguished from the salts of strychnia, which give well-marked crystalline precipitates with these three reagents.

Fig. 48.



Crystals of Morphia obtained by adding ammonia to a solution of the hydrochlorate, magnified 124 diameters.

Tests.—In order to apply the chemical tests for morphia, the alkaloid may be dissolved in a few drops of the diluted acid, either the acetic or the hydrochloric. If the hydrochlorate or the acetate of morphia is presented for analysis, the salt may be at once dissolved in a small quantity of boiling water. The tests for this alkaloid are the following: 1. *Nitric acid.* This, when added to a moderately strong solution of a salt of morphia, produces slowly a deep orange-red colour. If added to the crystals of morphia or its salts, nitric oxide is evolved:—the morphia is entirely dissolved, and the solution acquires instantly the deep red colour above described—becoming, however, lighter by standing. In order that this effect should follow, the solution of morphia must not be too much diluted, and the acid must be strong and added in rather large quantity. The colour is rendered much lighter by boiling; therefore the test should never be added to a hot solution. 2. *Iodic acid* with *sulphide* of *carbon.* A solution of iodic acid should be mixed with its volume of sulphide of carbon. There should be no change of colour. On adding a small quantity of these mixed liquids to morphia or its salts, either solid or in solution, the iodine is separated from the iodic acid and dissolved by the sulphide, which sinks to the bottom, acquiring a pink or red colour, varying in its intensity according to the quantity of morphia present. This reaction distinguishes morphia from the other alkaloids, which do not decompose iodic acid. The presence of morphia may be thus easily detected in one drop of the tincture of opium, in chlorodyne or other opiate liquids, in spite of the presence of organic matter. If sulphide of carbon is not used iodine may be detected by its odour, or by the blue colour produced on the addition of a solution of starch. 3. *Sulphomolybdic acid.* This is made by dissolving with a gentle heat five or six grains of powdered molybdate of ammonia in two drachms of strong sulphuric acid. The liquid should be freshly prepared and kept from contact with air and organic matter. When one or two drops are rubbed with *dry* morphia or any of its salts an intense reddish-purple or crimson colour is produced. This changes to a dingy green and ultimately to a splendid sapphire blue. A minute trace of morphia is thus revealed. This test produces no change in *strychnia*, but the mixture slowly acquires a pale blue tint. The presence of morphia in strychnia is thus easily detected. When poured on *brucia* this acquires a rose-red colour, becoming greenish-brown and ultimately dark blue. When mixed with *veratria*, the liquid becomes greenish-brown, and gradually passes to a darker shade. The margin becomes purple, and ultimately the whole mixture acquires a deep blue colour. On chloral hydrate sulphomolybdic acid produces no change.

4. *Sulphuric acid* and *bichromate of potash*. When strong sulphuric acid is poured on pure morphia in a solid state, there is either no effect, or the alkaloid acquires a light pinkish colour. On adding to this a drop of solution of bichromate of potash, or a small fragment of a crystal, it immediately becomes green (from the production of oxide of chromium), and retains this colour for some time. Other alkaloids (strychnia) are not thus affected. Narcotina is turned of a bright yellow by sulphuric acid; therefore, although it becomes green when mixed with bichromate of potash, it could not be mistaken for morphia: besides, the green rapidly passes to a dingy brown colour.

It may sometimes be desirable to determine whether morphia or any vegetable alkaloid is present in a suspected *solution*. For this purpose we may employ a solution of corrosive sublimate and iodide of potassium—the chloriodide of potassium and mercury (iodo-hydrargyrate of potash). If even a small quantity of morphia or any alkaloid is present, a whitish precipitate is thrown down on adding the test: this precipitate is an insoluble hydriodate of the alkaloid with iodide of mercury. This test is more sensitive with some alkaloids than others. A negative result proves the absence of morphia, provided the solution does not contain a large excess of alcohol or acetic acid, in either of which liquids the alkaloidal precipitate is soluble. It is not affected by ammonia, but it gives yellow peroxide of mercury with potash or soda. This solution may be employed in the analysis of most of the poisonous principles and alkaloids, some of which may by means of it be readily distinguished from others. It is made by dissolving sixteen grains of corrosive sublimate and sixty grains of iodide of potassium in four ounces of water. As it gives a precipitate with albumen, this, when present, should be first removed by boiling the liquid to be tested. Another delicate precipitant of solutions of the alkaloids is the iodide of potassium with iodine (Bouchardat's test). It is made by dissolving twenty-four grains of iodide of potassium and eight grains of iodine in one ounce of water. It gives a deep brown precipitate with an alkaloidal salt.

Meconic Acid.—This is a solid crystalline acid, seen commonly in scaly crystals of a pale reddish colour. It is combined with morphia in opium, of which, according to Mulder, it forms on an average 6 per cent.; and it serves to render this alkaloid soluble in water and other menstrua. *Tests.*—Many tests have been proposed for meconic acid; there is only one upon which any reliance can be placed, namely, the *perchloride* or *persulphate of iron*. This test produces, even in a diluted solution of meconic acid, a deep blood-red colour; and it is owing to the presence of this acid that a salt of iron strikes a red colour in tincture and infusion of opium, as well as in all liquids containing traces of meconate of morphia, the effects of the iron-test with morphia being counteracted by the presence of meconic acid. The red colour of the meconate of iron is not easily destroyed by diluted mineral acids or by a solution of corrosive sublimate, but it is by sulphurous acid and chloride of tin. In liquids containing tannic acid, *e.g.* tea or beer, the action of this test is obscured by the production of tannate of iron. The dark colour is removed by a few drops of diluted sulphuric acid.

Detection of Opium in Organic Mixtures.—Opium itself may be regarded as an organic solid, containing the poisonous salt which we wish to extract. It is not often that, in fatal cases of poisoning with opium or its tincture, even when these are taken in large quantity and death is speedy, we can succeed in detecting meconate of morphia in the stomach. It is probably removed by vomiting or absorption. If the matter is solid it should be cut into small slices; if liquid, evaporated to an extract; and, in either case, digested with a large quantity of rectified spirit, slightly acidulated with acetic acid. The residue should be well pressed in linen; the alcoholic liquid should then be evaporated in a water-bath until it is almost dry. The residue should be digested in water

filtered and treated with acetate of lead, until there is no further precipitation. This liquid should be boiled and filtered: meconate of lead is left on the filter, while any morphia passes through dissolved under the form of acetate. The surplus acetate of lead contained in the filtered liquid (containing the morphia) should now be precipitated by a current of sulphuretted hydrogen—the sulphide of lead separated by filtration, and the liquid evaporated at a very gentle heat to a dry extract, so that any sulphuretted hydrogen may be entirely expelled. On treating this extract with alcohol, the acetate of morphia, if present in sufficient quantity, will be dissolved. If the alcoholic liquid is still much coloured, it may be again evaporated and taken up by water. Animal charcoal deprives it of colour, but at the same time removes the morphia if this is in small quantity. If there is a sufficient quantity of pure acetate present, the addition of a drop of a weak solution of ammonia to a portion of the liquid on a slide, will produce crystals of the form of slender prisms which are somewhat deliquescent. The remainder may be tested by the nitric and iodic acids.

The *meconate* of lead left on the filter is readily decomposed by warming it with a small quantity of diluted sulphuric acid; and in the filtered liquid, neutralized if necessary by an alkali, the meconic acid is easily detected by the iron test. A current of sulphuretted hydrogen may be used in place of sulphuric acid. The sulphide of lead takes down with it much of the organic matter of the precipitate. There is no better method of obtaining meconic acid than this. Dr. Wormley has found that he could thus procure evidence of the presence of meconic acid and morphia from a complex organic mixture, containing only one grain of opium. ('Micro-chemistry of Poisons,' p. 497.) This analysis requires care as well as some practice in the operator, in order that the morphia should be obtained in a sufficiently pure state for the application of the tests.

Before resorting to this process, it is advisable to employ *trial tests* on the original liquid, in order to determine whether any meconic acid or morphia is present or not. The smell of opium may be entirely absent. Meconic acid may be readily detected by the action of a persalt of iron on the organic liquid diluted, and morphia may be found by adding to a portion of the liquid a mixture of iodic acid and sulphide of carbon. The sulphide acquires a pink colour by dissolving the iodine set free by morphia or its salts. These tests may be equally applied to a solution of opium obtained by dialysis. The chief difficulty in the detection of meconate of morphia is that the alkaloid does not form more than one-tenth part of opium, and the quantity of opium present in an organic liquid is generally very small.

CHAPTER 27.

PRUSSIC ACID—SYMPTOMS AND APPEARANCES—FATAL DOSE—TESTS FOR THE ACID—PROCESS FOR ORGANIC MIXTURES. CYANIDE OF POTASSIUM. ESSENTIAL OIL OF BITTER ALMONDS.

Hydrocyanic or Prussic Acid.

Symptoms.—This acid has a hot bitter taste and an odour resembling that of bitter almonds diluted. The time at which the symptoms of poisoning commence in the human subject, is liable to great variation from circumstances not well understood. When a large dose has been taken, as from half an ounce to an ounce of the diluted acid, the symptoms usually commence in the act of swallowing, or within a few seconds. It is rare that their appearance is delayed beyond *one or two minutes.* When the patient has been seen at this stage, he has been perfectly insensible, the eyes fixed and glistening, the

pupils dilated and unaffected by light, the limbs flaccid, the skin cold and covered with a clammy perspiration; there is convulsive breathing at long intervals, and the patient appears dead in the intermediate period; the pulse is imperceptible, and involuntary evacuations are occasionally passed. The respiration is slow, deep, gasping, and sometimes heaving, or sobbing. The following case, communicated to me by Mr. French, presents a fair example of the immediate effects of this poison in a large and fatal dose:—A medical man swallowed seven drachms of the common prussic acid. He survived about four or five minutes, but was quite insensible when discovered, *i.e.* about two minutes after he had taken the poison. He was found lying on the floor senseless; there were no convulsions of the limbs or trunk, but a faint flickering motion was observed about the muscles of the lips. The breathing appeared to cease entirely for some seconds: it was then performed in convulsive fits, and the act of expiration was remarkably deep, and lasted for an unusual time. When the dose is large, the breath commonly exhales a strong odour of the acid, and this is also perceptible in the room. Convulsions of the limbs and trunk, with spasmodic closure of the jaws, are usually met with among the symptoms; the finger-nails have been found of a livid colour, and the hands firmly clenched. The breathing is generally convulsive, but when the coma or insensibility is profound, it is sometimes stertorous. This was noticed in a case which occurred to Sir R. Christison. ('Edinburgh Monthly Journal,' February, 1850, p. 97.) It was also observed in the case of *Marcooley* (*Reg. v. Boroughs*, C. C. C., February, 1857). Stertorous breathing has not been hitherto recorded by toxicologists as one of the usual symptoms of poisoning by prussic acid. In the inquiry which took place at Rugeley, in January 1856, respecting the death of *Walter Palmer*, it was contended that the fact of the deceased having had stertorous breathing was a proof that he had died from apoplexy, and not, as it was alleged, from prussic acid; but the facts here recorded show that such an inference is erroneous.

When a small dose (*i.e.* about thirty minims of a weak acid) has been taken, the individual has first experienced weight and pain in the head, with confusion of intellect, giddiness, nausea, a quick pulse, and loss of muscular power; these symptoms are, however, sometimes slow in appearing. Vomiting has been occasionally observed, but it is more common to find foaming or frothing at the mouth, with suffusion or a bloated appearance of the face, and prominence of the eyes. If death results, this is preceded by tetanic spasms, opisthotonos, and involuntary evacuations. Vomiting is sometimes the precursor of recovery. (See cases in 'Medical Gazette,' vol. 36, p. 103; vol. 35, pp. 859, 893.) A case which occurred to Mr. Bishop ('Prov. Med. and Surg. Jour.' Aug. 13, 1845, p. 517) was remarkable in several particulars: the man swallowed, it was supposed, forty minims of an acid (at three and a quarter per cent.), and was able to give an account of his symptoms. He was conscious for some time after he had taken it, and he recollected experiencing the sensation of his jaws becoming gradually stiff and tight. One of the most marked effects of prussic acid is to produce insensibility and loss of muscular power, much more speedily than any other poison. In some instances, there may be loss of consciousness in a *few seconds*; in others, certain acts indicative of volition and locomotion may be performed, although requiring for their performance several *minutes*.

Appearances.—The body when seen soon after death often exhales the odour of prussic acid; but if it has remained exposed before it is seen, and if it has been exposed to the open air or in a shower of rain, the odour may not be perceptible; again the odour may be concealed by tobacco-smoke, peppermint, or other powerful odours. In a case in which a person poisoned himself with two ounces of the acid, and his body was examined twenty-eight hours after

death, the vapour of prussic acid, which escaped on opening the stomach was so powerful that the inspectors were seized with dizziness. In cases of suicide or accident, the vessel out of which the poison has been taken will commonly be found near; but there is nothing to preclude the possibility of a person throwing it from him in the last act of life, or even concealing it if the symptoms should be delayed. (See case by Christison, p. 298.) Owing to the great volatility of the poison, the vessel, if left uncorked, may not retain the odour when found. Putrefaction is said to be accelerated in these cases; but from what I have been able to collect, there seems to be no ground for this opinion (p. 101; also case in 'Prov. Med. Journ.' July 30, 1845).

Externally, the skin is commonly livid, or is tinged of a violet colour; the nails are blue, the fingers clenched, and the toes contracted; the jaws firmly closed, with foam or froth about the mouth, the face often pallid, but sometimes bloated and swollen, and the eyes have been observed to be wide open, fixed, glassy, very prominent and glistening, and the pupils dilated; but a similar condition of the eyes has been observed in other kinds of violent death. *Internally*, the venous system is gorged with dark-coloured liquid blood; the stomach and intestines may be in their natural state; but in several instances they have been found more or less congested. The mucous membrane of the stomach of a dog which died in a few minutes from a dose of three drachms of Scheele's acid, was intensely reddened throughout, presenting the appearance met with in cases of arsenical poisoning. In a large number of experiments upon dogs, the late Mr. Nunneley found generally a congested condition of the mucous membrane of the stomach: if empty at the time the poison was taken, the organ was found much contracted, and of a brick-red colour. This appearance of congestion was observed on the mucous membrane of the vagina, the rectum, and conjunctiva, when the acid was applied to these parts. ('Prov. Trans.' N.S. vol. 3, p. 79.) Redness of the stomach was noticed in the case of the Parisian epileptics. ('Ann. d'Hyg. 1829, 1, 507.) The late Dr. Geoghegan, of Dublin, communicated to me the particulars of a case in which this redness of the mucous membrane was well marked. In April 1847, a healthy man, æt. 30, swallowed a large dose of prussic acid. He was soon afterwards found dead in his bed. The body was inspected in five hours: rigidity had then commenced, and there was some warmth. The face was pale, the eyes were half closed, not presenting any remarkable brilliancy or prominence, and there was great dilatation of the pupils. The mouth was closed, and no froth issued from it. The abdomen was the only cavity examined. The muscles were red, and gave out, on section, a good deal of fluid blood, which had a strong odour of prussic acid; the odour of the poison was also perceptible in the abdomen. About eight ounces of a thick farinaceous mass were found in the stomach: the odour of prussic acid was very perceptible in this organ, but it was mixed with that of rancid food. The mucous membrane had everywhere, except at the greater end and posterior wall, a vivid inflammatory redness of a well-marked character, and it was covered with a layer of viscid mucus to a considerable extent. This membrane, even after it had been washed three times in water, gave out a strong odour of prussic acid. In a case which I examined in May 1850, in which death had been caused by a large dose of the acid, there was a generally congested state of the mucous membrane of the stomach. I am indebted to Mr. Blaker, of Lewes, for an account of the appearances found in the body of a medical student who destroyed himself in March 1860, by swallowing about one drachm of Scheele's acid. He was found in a state of collapse and breathing heavily, in about half a minute from the time at which he was last seen. He died in twenty minutes. The coats of the stomach were greatly congested towards the cardiac end. The minute vessels throughout were filled with dark blood, and there were some spots of effused blood beneath the mucous coat.

The intestines were highly congested, the small vessels being visible all over the coats. There was no congestion of the membranes of the brain. Dr. Frank has recorded the appearances in two cases which fell under his notice. (Horn's 'Vierteljahrsschrift,' 1868, 2, 179.)

Quantity required to destroy life.—The *smallest* dose of this acid which is reported to have caused death, was in a case which occurred to Mr. Hicks. ('Med. Gaz.' vol. 35, p. 896.) A healthy adult woman died in twenty minutes from a dose equivalent to *nine-tenths* of a grain of anhydrous prussic acid. This was equivalent to about *twenty grains* of Scheele's acid. In a case reported by Mr. T. Taylor ('Med. Gaz.' vol. 36, p. 104), a stout healthy man swallowed this dose, *i.e.* nine-tenths of a grain, by mistake, and remained insensible for *four hours*, when he vomited and began to recover. The vomited matters had *no odour* of the poison, showing that, if not concealed by other odours, the whole of the acid must have been absorbed. He had a very narrow escape of his life. Dr. Banks has published a case in which a female recovered after swallowing thirty drops of prussic acid. ('Ed. Med. Surg. Jour.' vol. 48, p. 44.) The *largest* dose from which an adult has recovered, was probably in a case which has been reported by Mr. Burman. ('Lancet,' Jan. 14, 1854.) His father, æt. 60, of a strong constitution, took by mistake a *drachm* of prussic acid, equivalent to 2·4 grains of anhydrous acid. In a few seconds he perceived the mistake, and swallowed half an ounce of aromatic spirits of ammonia with a little water. Four minutes after taking the poison, cold affusion was employed, and sulphate of iron and spirit of ammonia were administered. Vomiting with convulsive shuddering and insensibility took place. In twenty minutes consciousness returned, and fifteen minutes later he was able to walk up-stairs to bed. He perfectly recovered, but in the absence of the early treatment resorted to, it is most probable that he would have died. Sir R. Christison has reported in the 'Edinburgh Monthly Journal' (Feb. 1850, p. 97) the case of an adult who recovered after having taking a dose equivalent to a *grain and a half* or two grains of anhydrous acid. The treatment consisted in the evacuation of the stomach by the stomach-pump, and in pouring a current of cold water on the head. The symptoms were such that the man would have died, but for immediate treatment. It is a remarkable fact that in this case no bottle or vessel could be found in the room or under the window. The patient hastily summoned his wife one evening, told her that he had taken prussic acid, and immediately fell down senseless on a sofa, without either cry or convulsion, but drawing his breath deeply, forcibly, and slowly. He recovered in about three hours, but had an unusual disposition to sleep, even on the following day. Another remarkable case of recovery from a dose nearly as large occurred to Mr. Bishop. ('Prov. Med. Jour.' Aug. 13, 1845, p. 517.) From the facts hitherto observed, we shall not be wrong in assuming that a quantity of Scheele's acid (at five per cent.) *about twenty grains* (i.e. *one grain of anhydrous acid*), or an equivalent portion of another acid, would commonly suffice to destroy the life of an adult. This I believe to be the nearest approach that we can make to the *smallest fatal dose.* In *Reg.* v. *Bull*, tried at Lewes Autumn Assizes, 1860, a question arose respecting the minimum fatal dose of this poison. The accused, a young medical man, was charged with the manslaughter of his mother, a woman æt. 66. He had prescribed for her prussic acid to relieve sickness. He procured a bottle of Scheele's acid, said to contain one drachm. He administered four minims to deceased in the morning, and it appeared to benefit her. In the evening he gave to her another dose amounting, according to his statement, to 'seven drops.' The deceased went up-stairs, became insensible, and died in a few minutes. When the bottle was examined twenty-five minims remained in it: hence thirty-five minims were alleged to be missing, but the druggist who sold the acid poured out the quantity conjecturally, and the bottle was found to have a broken cork. The

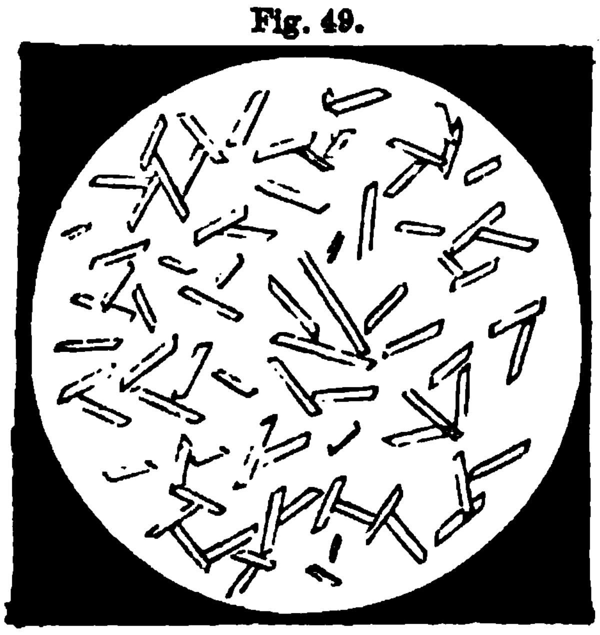
strength of the acid had not been determined. Under these circumstances the prisoner was acquitted. In this case the Court desired to know the relation of drops to minims, but no satisfactory answer could be given. The size of a drop materially depends on the nature of the liquid, the mouth of the bottle, and the rapidity of the measurement. Seven drops of Scheele's acid dropped from a small phial measured seven minims. There can be no doubt in the above case that the poison caused death, and unless we assume that seven drops or minims will destroy life, which is not probable, the deceased must have taken a much larger dose than the accused had intended.

Period at which death takes place.—When the dose is two drachms and upwards, we may probably take the average period for death at from *two* to *ten* minutes. In Mr. Hicks's case, twenty grains of Scheele's acid destroyed life in twenty minutes. It is only when the dose is just in a fatal proportion, that we find a person survive from half an hour to an hour. In this respect, death by prussic acid is like death by lightning; the person in general either dies speedily or recovers altogether. According to Dr. Lonsdale, death has occurred in the human subject as early as the *second*, and as late as the *forty-fifth* minute. But although death does not commonly ensue until after the lapse of a few minutes, sensibility, and consequently a power to perform certain acts of volition and locomotion, may cease in a few seconds. The time at which this loss of muscular power is supposed to take place has frequently become an important medico-legal question; and on the answer to it the hypothesis of suicide or murder in a particular case may rest.

Chemical Analysis.—Prussic acid is limpid like water; it possesses a faint acid reaction, and its vapour has a peculiar odour, which when the acid is concentrated, although not at first perceptible, is sufficient to produce giddiness, insensibility, and other alarming symptoms. The tests which are best adapted for the detection of this poison, either in liquid or vapour, are equally applicable whether the acid is concentrated or diluted, and, so far as the detection of the *vapour* is concerned, whether the acid is pure or mixed with other liquids or solids. *In the simple state*, the tests are three in number: the *Silver*, the *Iron*, and the *Sulphur* tests.

1. *The Silver-test. Nitrate of Silver.*—This yields, with prussic acid, a dense white precipitate, speedily subsiding in heavy clots to the bottom of the vessel, and leaving the liquid almost clear. The precipitate is identified as cyanide of silver by the following properties:—*a.* It is insoluble in cold nitric acid; but when drained of water, and a sufficient quantity of strong acid is added, it is easily dissolved on boiling. *b.* It evolves prussic acid, when digested in hydrochloric acid. *c.* The precipitate, when *well dried*, and heated in a small reduction tube, yields cyanogen, which may be burnt as it issues, producing a rose-red flame with a blue halo. This is a well-marked character, and at once identifies the acid which yielded the precipitate as prussic acid. By this property, the cyanide is eminently distinguished from all the other salts of silver. In the employment of the silver-test for the detection of the *vapour* of the poison, we place a few drops of the silver solution in a watch-glass, and invert it over another watch-glass or beaker containing the suspected poisonous liquid. Cyanide of silver, indicated by the formation of an opaque white film in the solution, is immediately produced, if only in a moderate state of concentration. One drop of a diluted acid containing less than 1-50th of a grain of the

Fig. 49.



Crystals of Cyanide of Silver from the vapour of prussic acid, magnified 124 diameters.

anhydrous acid produces speedily a visible effect. When the prussic acid is more diluted, a few minutes are required; and the opaque film begins to show itself at the edges of the silver solution. In this case the action may be accelerated by the heat of the hand. If the vapour is allowed to reach the nitrate of silver gradually and much diluted with air, then instead of an opaque film of cyanide of silver, crystals well defined under the microscope will be slowly produced, and these will constitute an additional proof of the presence of the acid in a state of vapour. As shown in the annexed illustration (fig. 49), these crystals have the form of slender prisms with oblique terminations. They often hang together in groups, and generally require a high magnifying power to render them visible.

2. *The Iron-test.*—The object of the application of this test, is the production of *Prussian blue.* We add to a small quantity of the suspected poisonous liquid, a few drops of a solution of potash and of green sulphate of iron. A dirty green or brownish precipitate falls; on shaking this for a few minutes, and then adding diluted hydrochloric or sulphuric acid, the liquid becomes blue; and Prussian blue of its well-known colour, unaffected by diluted acids, subsides. If the prussic acid is in small quantity, the liquid is at first yellow, from the salt of iron formed; it then becomes green, but the precipitate ultimately subsides so as to appear of a deep blue colour in the mass. The iron-test may be employed for the detection of the *vapour* of prussic acid, by the same method as that described in speaking of the silver-test. For this purpose we place a few drops of a solution of potash in a watch-glass or saucer, and invert it over the suspected liquid. After a few minutes' exposure a drop of solution of green sulphate of iron may be added, and then a drop of diluted hydrochloric acid, when Prussian blue will appear. The silver and the iron-tests may be easily conjoined in testing the same quantity of poison. If the precipitated cyanide of silver, obtained by the addition of nitrate of silver to the suspected liquid, is dried and then moistened with strong hydrochloric acid, the vapour may be collected in a watch-glass or saucer, on the plan above described. Prussian blue will be procured, and thus corroborate the action of the silver-test.

3. *The Sulphur-test.*—Some years since Liebig proposed the following process for detecting prussic acid as a *liquid.* ('Oesterreichische Med. Wochenschrift,' März 27, 1847, p. 396.) If a small quantity of the bisulphide of ammonium is added to a few drops of a solution of prussic acid, and the mixture is gently warmed, it becomes colourless, and, on evaporation, leaves crystals of sulphocyanate of ammonia—the sulphocyanic acid being indicated by the intense blood-red colour produced on adding to the dry residue a solution of a nearly neutral persalt of iron: this red colour immediately disappears on adding a few drops of a solution of corrosive sublimate. The colour is also destroyed by strong acids, and its intensity is diminished by moderate dilution with water. This process is very delicate, and it therefore requires some care in its application: thus, if the boiling and evaporation are not carried far enough, the persalt of iron will be precipitated black by the undecomposed sulphide; and, if the heat be carried too far, the sulphocyanate of ammonia may itself undergo decomposition, and be lost. It will be perceived, too, that it requires a longer time for its application than either the silver or the iron-test. If the prussic acid contains traces of Prussian blue or a salt of iron, it will acquire a dark colour on the addition of the sulphide.

The great utility of the *sulphur-test*, however, is in its application to the detection of the minutest portion of prussic acid when in a state of *vapour.* In this respect it surpasses any other process yet discovered. In order to apply it, we place the diluted prussic acid in a watch-glass, and invert over it another watch-glass, holding in its centre one drop of the bisulphide of ammonium.

No change apparently takes place in the sulphide; but if the watch-glass is removed after the lapse of from half a minute to ten minutes, according to the quantity and strength of the prussic acid present, crystallized sulphocyanate of ammonia will be obtained on gently evaporating the liquid to dryness. With an acid of from three to five per cent. the action is completed in ten seconds. The addition of one drop of the neutral persulphate of iron (free from nitric acid) to the dried residue, brings out the blood-red colour instantly, which is intense in proportion to the quantity of sulphocyanate present. Such is the simple method of employing the vapour test. When the prussic acid is much diluted, the warmth of the hand may serve to expedite the evolution of the vapour. I have elsewhere made some remarks on the application of this process for the detection of prussic acid. (See 'Med. Gaz.' 1847, vol. 39, p. 765.)

Prussic Acid in organic liquids. Detection by vapour without distillation.—The organic liquid may be placed in a wide-mouthed bottle, to which a watch-glass has been previously fitted as a cover. The capacity of the bottle may be such as to allow the surface of the liquid to be within one or two inches of the concave surface of the watch-glass. The solution of *Nitrate of silver* is then used as a trial-test in the way already described. If the 1-200th of a grain of prussic acid is present, and not too largely diluted, it will be detected (at a temperature of 60°) by the drop of nitrate of silver being converted into an opaque white or crystalline film of cyanide of silver, the chemical change commencing at the margin. We may then substitute for the nitrate of silver the bisulphide of ammonium, and proceed in the manner above described. It may be sometimes necessary to place the bottle in a basin of warm water. If the solution of silver is tarnished by sulphuretted hydrogen, as a result of putrefaction, the sulphur-test alone should be used. By this process I have detected prussic acid in the stomach of a person poisoned by it, as late as twelve days after death. After the stomach had been exposed for a few days longer, all traces of the poison had disappeared.

Detection by distillation.—This process was originally suggested by Lassaigne. The organic liquid should be distilled in a water-bath at 212°, and about one-sixth or one-eighth of the contents of the retort, collected in a receiver kept cool by water. The tests may now be applied to the distilled liquid. If the trial-test indicate that the quantity of poison is small, a solution of nitrate of silver or caustic potash may be placed in the receiver, to fix the acid as it is distilled over; Prussian blue may then be procured in the manner described, or the vapour may be at once absorbed by bisulphide of ammonium in the receiver, and the liquid evaporated to obtain sulphocyanate. Prussic acid has been found in the stomach by *distillation*, so late as *seven* days after death, although the odour could not be perceived before distillation. In the case of *Montgomery* (Report of trial of *Thompson*, Glasgow Circuit Court, 1857, by Hugh Cowan, pp. 9 and 53), the deceased died in about fifty minutes after having taken two drachms of prussic acid (equivalent to three and a quarter grains of anhydrous acid). The death took place on the 13th September: the body was buried on the 17th, and exhumed on the 30th. The parts removed were then put into stoppered bottles, and on the 5th October the Drs. McKinlay detected prussic acid doubtfully by the odour, but distinctly by the three tests,—in the stomach, before distillation, as well as in the liquid distilled from the stomach and its contents. They did not succeed in detecting its presence in the tissues. About five weeks subsequently to this analysis, the viscera, which had been kept closely secured in glass bottles, were examined by Dr. Maclagan. The heart, kidneys, and intestines gave no indication of the presence of the poison, but it was detected by the sulphur-test, in the form of vapour, in one half of the spleen, although there was no odour of the poison. When the viscera containing the poison have undergone putrefaction, no trace of the acid

may be found either by its vapour or by distillation. In this case it may have been converted into sulphocyanate of ammonia by the sulphide of ammonium produced during putrefaction. The sulphocyanate may then be dissolved out of the dried viscera or liquids by alcohol, and the solution evaporated to dryness, the residue redissolved in water and tested by a persalt of iron. Much is lost by reason of the great volatility of the acid. I have found the vapour to traverse paper and wet and dry bladder in a few minutes. Hence all viscera suspected to contain prussic acid should be preserved in well-stoppered glass bottles.

In the Tissues.—Soon after death the poison may be easily detected in the blood, secretions, or any of the soft organs, by placing them in a bottle, and collecting the vapour in the manner already described. This will be found to be far more convenient and satisfactory than the process by distillation. In the case of a dog poisoned by a large dose of prussic acid, Mr. Hicks brought to me the stomach after it had been exposed twenty-four hours, and thoroughly washed under a current of water, and yet the poison was readily detected by placing the whole organ in a bottle, and absorbing the vapour by nitrate of silver. This shows how completely the animal tissues at death are penetrated by prussic acid, and how firmly for a time it is retained by them. The poison has been thus discovered, in experiments on animals, in the blood and in the serous exhalation of the chest.

Cyanide of Potassium.

Symptoms.—This salt has a bitter taste, producing first a sense of coldness on the tongue, followed by a feeling of constriction, and burning heat, in the throat. It is one of the most formidable poisons known to chemists. It has destroyed life in a quarter of an hour. A dose of five grains has proved fatal in three instances. In one case the person died in two hours. ('Chem. News,' Sept. 5, 1863.) The symptoms which the cyanide produces are similar to those occasioned by prussic acid:—insensibility, spasmodic breathing, convulsions, with tetanic stiffness of the jaws and body. They appear in a few seconds or minutes, and run through their course with great rapidity.

Insensibility is not always an immediate symptom. A woman, who at the time was under medical treatment, took by mistake a teaspoonful of a solution of cyanide of potassium, containing about seven grains of the salt. Immediately after taking it she complained of a severe burning pain in the stomach, and a feeling as if the bowels were about to act. She went to the water-closet, and her strength left her. She was removed to bed, and speedily became unconscious. It was found impossible to introduce anything into the stomach. She died in less than an hour. There was no convulsion before death, but a sudden convulsive action of the body took place after the heart had ceased to beat. The appearance of the body was so natural, even on the day following death, that some of her friends supposed there might still be life. ('Boston Medical and Surgical Journal,' Dec. 11, 1856, and 'Brit. and For. Med. Rev.' 1857, vol. 19, p. 498.) In June 1856, a woman swallowed an ounce and a half of a solution of cyanide of potassium, used for photographic purposes. The quantity taken amounted to five grains. In two minutes she became unconscious, the whole of the body was slightly convulsed, and the pupils of the eyes were dilated. She foamed at the mouth, the pulse was small and feeble, and there was spasmodic closure of the jaws. Nevertheless, as she had lost some teeth, there was sufficient space for the introduction of the tube of the stomach-pump, within five minutes after she had taken the poison. She died in twenty minutes. In the Registrar-General's Report for Oct. 3, 1857, three deaths are stated to have occurred from this salt, among the families of soldiers; two were cases of suicide and one of accident. It appears that they

employed it for cleaning lace. In the four years, 1863–7, one hundred and fifty-one deaths are reported to have been caused by prussic acid and cyanide of potassium. (For cases of its fatal action see 'Med. Times and Gaz.' Oct. 12, 1850, p. 390; Nov. 9, 1850, p. 482; and July 12, 1851, p. 41; also, 'Chem. News,' April 27, 1861, p. 260.) The salt is much used by photographers, and has given rise to many accidents among persons engaged in the practice of this art.

Appearances.—In a case in which an inspection of the body was made two days after death, there was no remarkable odour:—the muscles were stiff and rigid; the face, and fore part of the body, pale; the back part livid, except those portions which had sustained pressure. The fingers and toes were convulsively bent inwards, the nails blue, eyelids half-closed, lips pale, the vessels of the brain filled with bluish-red (*blaurothem*) blood. On making a section of the brain and spinal marrow, bloody points were observed. The lungs were congested posteriorly, and on cutting into them a strong odour of bitter almonds was perceived. A yellowish mucus was found in the stomach, which yielded on analysis cyanide of potassium. The mucous membrane was reddened near the intestinal end. The poison was not detected in any part of the body except the contents of the stomach and intestines. (Casper's 'Wochenscrift,' Oct. 4, 1845, p. 657.) In Nov. 1851, a girl, æt. 18, was brought to Guy's Hospital. Half an hour before her admission, she was seen to swallow a solution of cyanide of potassium. She vomited once. It is stated that she was alive when put into the cab, but when taken out at the hospital seven minutes afterwards, she was completely insensible, pulseless at the wrist, and to all appearance dead. Artificial respiration was at once resorted to, ammonia was applied to the nostrils, warmth to the limbs, and cold affusion to the spine; but all to no effect, and with the exception of an alteration in the pupils observed during the first few minutes of her admission, she evinced no signs of vitality. The body was inspected on the following day. The stomach contained a large quantity of half-digested food: its mucous membrane was of a pink colour and deeply injected, especially in patches. Every other organ was healthy, and there was no appearance of corrosion about the mouth. The contents of the stomach were of a pale straw-colour, semi-fluid, and had a decidedly bitter almond odour. Prussic acid was detected in them. (See also a case by Dr. Ellis, 'Lancet,' Oct. 17, 1868, p. 447.)

This poison is generally fatal. Two cases of recovery from large doses are however reported by Mr. Stevenson ('Lancet,' 1871, 1, 806). A rare instance of recovery was communicated to me by Mr. Taafe, of Brighton. In March 1862, a man swallowed the greater part of a solution containing an ounce of the commercial cyanide, which he had dissolved for the purpose. Mr. Taafe found the man a few minutes afterwards lying in the street insensible, and breathing stertorously; and in about ten minutes he applied the stomach-pump with cold affusion freely. In two hours the man vomited, and from that time rapidly recovered. The commercial cyanide frequently contains a large quantity of carbonate of potash.

Cyanide of potassium has a local chemical action upon the skin; and if this is abraded or wounded, it may be absorbed and produce serious effects. Some accidents of this kind have occurred in the practice of photography. ('Ann. d'Hyg.' 1863, 1, 454.)

Analysis.—Cyanide of potassium is usually seen in hard white masses. It is deliquescent, and very soluble in water: the solution, when pure, is colourless, and has a strong alkaline reaction, a soapy feel, and a powerful odour of prussic acid. It is not very soluble in pure and strong alcohol. 1. It is decomposed by all acids, and prussic acid is set free. 2. The potash is precipitated by tartaric acid and chloride of platinum. 3. It gives a white pre-

pitate with nitrate of silver, which, when dried and heated, possesses all the properties of cyanide of silver. This precipitate is easily redissolved by a slight excess of the solution of cyanide of potassium. 4. If a solution of green sulphate of iron is added to a solution of the cyanide of potassium, and after agitation, diluted sulphuric acid, Prussian blue will result. 5. A single grain of this salt moistened with water in a watch-glass, gives a well marked reaction, by its vapour, with the silver and sulphur-tests. Should this experiment fail, a drop of the bisulphide of ammonium may be heated with the cyanide —the liquid acidulated with hydrochloric acid, and a solution of persulphate of iron added. The red colour of the sulphocyanate of iron is immediately brought out.

Organic Substances.—The salt may be obtained as a soluble fixed residue from organic matter by drying and incinerating it in close vessels; or prussic acid may be at once procured by distilling the contents of the stomach with diluted sulphuric acid.

Essential Oil of Bitter Almonds.

This liquid, which is used for the purpose of giving flavour and odour to confectionery, owes its poisonous properties chiefly to the presence of prussic acid. It contains a variable quantity of the acid, sometimes amounting to the large proportion of twelve per cent. *Almond flavour* or essence of peach kernels contains one drachm of the essential oil to seven drachms of rectified spirit. Thirty-one deaths from this oil are reported to have occurred in England and Wales in four years.

Symptoms.—The following may be taken as a summary: lividity of the face; eyes glassy, prominent, fixed and staring; pupils dilated and insensible to light; jaws spasmodically closed; frothy mucus about the mouth; in some cases vomiting of food; coldness of the skin; heaving and intermittent respiration, sometimes stertorous; absence of the pulse; head spasmodically drawn backwards, and sometimes the trunk; general relaxation of the limbs; an odour of bitter almonds about the mouth.

In a case the particulars of which were communicated to me by Dr. Bull of Hereford, a woman swallowed about seventeen drops of the essential oil, and she died in half an hour. She was seen by Dr. Bull in about fifteen minutes: her face was livid; the lips were separated; the teeth clenched; there was froth about the mouth; the eyes were half-shut and glassy; the pupils dilated and fixed; there were heavings of the chest at intervals; there was no pulse, and the action of the heart was scarcely perceptible. No odour was perceived about the body until after the stomach-pump had been used. The first symptoms observed in this case were strong convulsions, the deceased throwing her arms about as if in pain. A boy, æt. 18, swallowed a quantity of the oil; he was found lying on the floor motionless and insensible; his face pale; his eyes open and fixed, the pupils dilated, and he was rolling about and panting for breath; the pulse at the wrist was imperceptible; he died in a quarter of an hour without any convulsions appearing. A man, æt. 20, swallowed about two ounces of the oil. A person present saw him fall suddenly while in the act of swallowing, he made a loud cry, gave one deep expiration, and died.

In another case, a woman, æt. 46, who had been in the habit of using the almond essence for flavouring confectionery, swallowed about half an ounce (thirty drops of the oil). She died in less than half an hour. When seen by a medical man ten minutes after she had taken the poison, she was perfectly insensible. The face was pale but swollen, and covered with perspiration; the eyes stared fixedly as if in terror; the pupils were dilated. The lips were partly closed and livid, and a frothy mucus issued from the mouth. The lower jaw was firmly contracted, while the muscles of the neck and of the limbs, ex-

cepting those of the fingers, were flaccid. She breathed slowly and heavily, making about ten respirations in a minute; the pulse was from 30 to 40, and feeble. There was an odour of bitter almonds in the breath. Some blood which was drawn from the arm was thick and dark, resembling choleraic blood. In spite of the use of the stomach-pump and cold affusion, the patient did not show any signs of recovery, but gradually sank. ('Assoc. Med. Jour.' Dec. 13, 1856, p. 1055.) In March 1853, a woman, æt. 39, swallowed half an ounce of *almond flavour*, containing half a drachm of the essential oil. In ten minutes she was seen by Mr. Phillips, who found her perfectly insensible and motionless; the pupils were moderately dilated and insensible to light; the mouth was partly open, the lips were pale, there was no distortion or spasmodic movement of the features; the pulse was slightly tremulous, and entirely ceased in a few minutes; the breathing was slightly stertorous, and took place at long intervals. She continued in this state for twenty minutes without any convulsive movements of the body, when she died, *i.e.* half an hour after she had taken the poison. In another case two drachms destroyed life in seventeen minutes. ('Lancet,' Oct. 17, 1863, p. 447.)

Appearances.—In Dr. Bull's case (*supra*), on inspection nine hours after death no odour of almonds was perceptible in the chest, head, or heart, nor in the venous blood with which the system was gorged. The lungs and heart were healthy. The vessels of the brain were congested, and there was a general effusion of serum on the hemispheres. The lining membrane of the stomach was much congested. On opening it the bitter-almond odour was quite perceptible. (See 'Prov. Med. Jour.' Sept. 11, 1844, p. 364.) In the case of the boy (*supra*), which proved fatal in a quarter of an hour, on inspection there was pallor of the face, with lividity of the depending parts; the lungs were congested; the odour of the poison was perceptible only in the abdomen, and very distinctly in the contents of the stomach. The mucous coat of this organ was generally pale, but there were some patches of ecchymosis scattered over it. The essential oil and prussic acid were detected in it. ('Lancet,' July 12, 1845, p. 40.) In a case which proved fatal in three hours, the skin was partially livid, the blood fluid, and the membranes of the brain as well as the lungs were gorged. The contents of the stomach had a strong smell of the oil, and the mucous coat towards the intestinal opening had a red appearance. The other organs were healthy. The blood, with which the venous system is gorged, is generally liquid and of a dark colour.

Analysis.—The *essential oil*, which is often called peach-nut oil, is colourless when pure, but it commonly has a pale yellow colour, and a strong odour of bitter almonds, by which it may be at once identified. It has a hot, burning taste, and a feebly acid reaction. It produces, when dropped on paper, a greasy stain which does not entirely disappear by the application of heat. It has a sp. gr. of 1·043; it sinks in water, which dissolves about one-thirtieth part. It is soluble in alcohol and ether in all proportions. When mixed with a few drops of strong sulphuric acid, it forms a rich crimson-red liquid which, if exposed to air, acquires a yellow colour. When poured into cold water, the crimson liquid is immediately destroyed, and a yellow colouring matter falls in globules. The smell and taste of this oil are sufficient for its identification; but nitrobenzole possesses the same odour, and has been mistaken for it. When pure and free from prussic acid, it is rapidly converted by oxidation into crystallized benzoic acid. The impure oil undergoes this change slowly.

The vapour of prussic acid does not so readily escape from this oil as from the watery solution: hence the vapour-tests do not give the same characteristic results. *Tests.* 1. Add to one or two drops of the oil a like quantity of bisulphide of ammonium. Mere mixture at a low temperature only produces sulphocyanate after standing ten minutes or longer: but if the liquid is warmed

to 100°, the conversion is immediate, and the change is indicated by the blood-red colour struck on adding to the liquid persulphate of iron. If any unchanged sulphide should give a black colour, this may be removed by the addition of one or two drops of hydrochloric acid. 2. Dissolve one or two drops of the oil in alcohol and add to the mixture a few drops of a solution of potash, followed by a solution of green sulphate of iron and hydrochloric acid. Prussian blue is formed on agitating the mixture, but it does not appear until the precipitated oxide of iron is dissolved by the addition of diluted sulphuric or hydrochloric acid. The silver-test is inapplicable to the oil in its ordinary state. The vapour of the oil produces no change in a drop of a solution of nitrate of silver, except after long exposure. If, however, the oil be heated, there is an immediate production of cyanide of silver. The two tests above mentioned, combined with the odour, are sufficient for all practical purposes.

Bitter almond water, laurel water, and the essences of peach and cherry kernels, owe their noxious properties to the presence of prussic acid.

CHAPTER 28.

NARCOTIC LIQUIDS AND VAPOURS—SULPHIDE OF CARBON—COAL-NAPHTHA—WOOD-NAPHTHA — BICHLORIDE OF METHYLENE — AMYLENE — FUSEL-OIL. AMYLIC ALCOHOL—BENZOLE—NITROBENZOLE—ANILINE—OIL OF WORMWOOD—ABSINTHE —NITROGLYCERINE OR GLONOINE.

SULPHIDE OF CARBON.

THIS liquid is extensively used in the arts as a solvent for phosphorus, sulphur and caoutchouc. Nothing is known of its effects on man as a liquid; and from its powerful and offensive odour it could not be readily administered with homicidal intention. The effects of its vapour have been chiefly observed among workers who employ this liquid. It produces headache, loss of appetite, colicky pains, impairment of vision and hearing, and causes general derangement of health, evidently by an operation on the nervous system. (See 'Chem. News,' May 2, 1863, p. 216.) Several cases of poisoning by this vapour in vulcanized rubber factories have occurred to Dr. Bernhardt. (Husemann's 'Jahresbericht,' 1872, p. 495.)

Analysis.—The odour and inflammability of this liquid are sufficient to identify it even in the smallest quantity.

COAL-NAPHTHA.

The light oily product of the distillation of coal, known under the name of coal-naphtha, and chemically described as a hydrocarbon, has caused death in one case, under symptoms of narcotic poisoning. A boy, æt. 12, swallowed inadvertently about three ounces of coal-naphtha, in the state in which it is used for burning in lamps. He soon appeared as if intoxicated, and ran about in a wild delirium. When seen in a short time by a medical man, he was insensible —in a state of collapse—breathing stertorously, and his skin was cold and clammy. He had already vomited part of the liquid, and the odour of the vomited matter at once showed that he had taken coal-naphtha. By the promotion of vomiting, he was made to eject altogether two tablespoonfuls of naphtha, and he partially recovered. In spite of this reaction, however, in about two hours he was again in a state of collapse, insensible, pulseless, gasping for breath, and frothing at the mouth. The eyes were fixed and glassy, and the pupils contracted. There was complete loss of muscular power, and

great difficulty of breathing, but no convulsions. He had lost the power of swallowing. In spite of every effort to save him, he died in less than three hours after swallowing the liquid. On inspection of the body four days after death, a strong smell of naphtha was perceived throughout the tissues. The blood was fluid, there was slight effusion of serum in the ventricles of the brain. The right side of the heart contained fluid blood, the left was empty, the lungs were not congested but pale. The coats of the stomach were not inflamed or materially changed in appearance. This organ contained a pint of semifluid matter, of which four or five ounces were liquid. An ounce of a dark-coloured liquid floated on the top, and was easily skimmed off. This was found to be naphtha by its lightness, its insolubility in water, and by its inflammability. It burnt with a thick smoky flame. The liquid appeared to act in this case as a pure narcotic. There were no convulsions. The respiration of the *vapour* of this liquid diluted with air produces headache, giddiness, severe pain in the stomach, loss of appetite and general illness. ('Lancet,' Aug. 23, 1856, p. 230.)

Analysis.—The peculiar odour as well as inflammability of the liquid, and the fact that it burns with a bright yellow smoky flame, would be sufficient to identify coal-naphtha. Its lightness and insolubility in water would, as in the case above mentioned, allow of its being readily separated from the aqueous contents of the stomach.

Wood-Naphtha. Wood-Spirit. Methyl Alcohol.

The term Naphtha is frequently applied to a product of the destructive distillation of wood, differing entirely in composition and properties from the hydrocarbon above described as coal-naphtha. It is also known under the names of methyl alcohol and pyroligneous ether. It differs from coal-naphtha, among other properties, in being miscible with and soluble in water, in all proportions. It is a nauseous liquid in odour and taste. When mixed in the proportion of one-tenth part with rectified spirit, it forms a compound now largely employed as a solvent in the arts and medicine under the name of *Methylated spirit*. It has a hot disagreeable spirituous taste, and like rectified spirit it would no doubt operate as a narcotic poison. Its odour is so powerful and peculiar, that no one could swallow it unknowingly. I have met with only one instance of the effects of this liquid on man; but I have seen the effects produced by the respiration of its vapour on a large scale. It causes headache, loss of appetite, nausea, sickness, languor, and a general feeling of illness. A fatal case from an overdose of wood-spirit mixed with alcohol occurred in London in September in 1864, and was the subject of an inquest. The evidence showed, on an inspection of the body, that the lungs were congested and the stomach irritated and inflamed.

Analysis.—It is one of the most inflammable of liquids, burning with a pale blue flame. It is light and volatile, readily separable from other liquids by distillation below 200°. Its odour is peculiar. It mixes with water and alcohol in all proportions. Alcohol containing one-tenth part of it is rendered so nauseous that it cannot be used for the purposes of drinking.

Bichloride of Methylene.

The vapour of this highly volatile liquid has been proposed by Dr. Richardson as a substitute for the vapour of chloroform in surgical operations. It was thought to be less likely to cause death. Like all anæsthetic vapours it has however destroyed life on several occasions, even when given with care. The history of these fatal cases is similar to that which chloroform vapour has furnished on numerous occasions.

Symptoms and Appearances.—In 1870 an operation for artificial pupil was about to be performed on a man, æt. 40. The vapour of the bichloride was given, and five minutes afterwards, when the operation had just commenced, the face of the man became livid, the breathing difficult, and the heart suddenly ceased to beat. On inspection the principal appearance was congestion of the lungs. In another case, which occurred in 1871, a man inhaled, for the purpose of a trivial operation, a drachm and a half of the bichloride. It was given in the usual way by an experienced person, and was stated to be not more than one-half of the usual dose. The deceased became insensible—the operation was completed in a minute—when it was noticed that the patient's head had fallen on one side, his eyes were upturned and breathing and pulsation had ceased. Animation could not be restored. On inspection all the organs of the body were found healthy. There was no cause for death but the vapour of the bichloride ('Pharm. Journal,' 1871, p. 875). This preparation has been sometimes used in hospitals under the name of chloroform. In October 1869, a man to whom the vapour was administered at Charing Cross Hospital died in two minutes from the effects—although administered with care, and by one experienced in the use of chloroform. The allegation, therefore, that this vapour possesses any greater degree of safety than chloroform in surgical practice is not supported by facts.

Analysis.—This liquid has a peculiar odour resembling that of chloroform. It is not inflammable, but burns in contact with flame with a smoky combustion. It is not very soluble in water, but sinks in it, the globules having an opaque appearance. It has no acid reaction. Nitrate of silver gives no precipitate with it. In contact with sodium and a small quantity of water, it is rapidly decomposed without combustion; the liquid acquires a yellowish colour, and chlorine is then readily detected in it by nitrate of silver.

A mixture of chloroform and ether has been sold as bichloride of methylene. On shaking this mixture with water the chloroform is separated and sinks.

Amylene.

The vapour of this liquid was introduced by the late Dr. Snow as a substitute for the vapour of chloroform. It produces a loss of sensibility without causing complete coma or stupor. Its use has already led to at least two deaths, and it is not so safe an agent as chloroform vapour for surgical purposes. The only *appearance* met with in one fatal case, was an emphysematous state of the lungs or excessive dilatation of the air-cells ('Med. Times and Gazette,' April 4 and 18, 1857, pp. 332, 381); and in the other, a distension of the right cavities of the heart with dark fluid blood. There was no congestion of the brain, and no smell of amylene perceptible in the body. ('Med. Times and Gazette,' Aug. 8, 1857, p. 133.)

Fusel-Oil. Amylic Alcohol.

This liquid is also known under the name of Potato-spirit or oil of grain. It is of an alcoholic nature, but much less volatile than alcohol and ether: hence it is commonly a product at the latter part of the distillation of spirit from fermented potatoes and cereal grains, imparting a disagreeable odour and taste to the brandies produced. Its vapour when respired in a diluted state is irritating to the lungs; it produces headache, nausea, and a feeling of giddiness, with a sense of suffocation and inability to stand or walk. This spirit is used in certain manufactures, as in the separation of oils and fats, and a question has arisen how far the vapours would be injurious to the health of workmen. There can be no doubt that the vapour is noxious when breathed, and that the work could not be carried on with safety unless there were free and perfect ventilation.

Dr. Furst, of Berlin, found that two drachms of the liquid thrown into the stomach of a rabbit caused great restlessness and loss of muscular power; but the animal soon recovered. A similar quantity killed another rabbit in about two hours: the principal symptoms were great depression and difficulty of breathing. On inspection of the body, there was extravasation of dark brown blood at the gullet end of the stomach, and the mucous membrane presented brownish-red points. The lining membrane of the upper part of the small intestines was reddened and covered with mucus: the kidneys were healthy and bloodless, and the lungs somewhat redder than natural. Three drachms killed a rabbit within an hour. Half an ounce caused death in a quarter of an hour, and one ounce in four minutes. Fusel-oil, as a liquid, appears to have at first a stimulating and afterwards a depressing action. In small quantities it produces intoxication. (See 'London Med. Gaz.' vol. 35, p. 430.) This liquid is absorbed into the blood, and after a time may be detected by its peculiar odour in the breath. Its toxicological effects are more powerful in the state of vapour than when it is taken as a liquid into the stomach.

Analysis.—Fusel-oil is a volatile liquid of a pale yellow colour, lighter than water and only sparingly soluble in it. It is dissolved by alcohol and ether in all proportions, but not readily by chloroform. Water separates it from its ethereal solution. It has a hot burning taste and an offensive spirituous odour, which is very persistent and peculiar: by this it may be distinguished from other alcoholic liquids. It is inflammable, and burns with a pale bluish flame. Like alcohol, ether, and wood-spirit, it decomposes chromic acid, producing green oxide of chromium. In organic mixtures ether might be used for its separation. By distilling one part of fusel-oil with two parts of acetate of potash and one part of oil of vitriol, an ethereal liquid is produced which is used in confectionery under the name of *Essence of Jargonelle Pear.* A child on two occasions became partially comatose and had livid lips and a feeble pulse, after eating some confectionery which it was calculated contained about one drop of this essence. Hence its use is not without danger. (See 'Pharm. Jour.' Nov. 1851, p. 214.)

Benzole.

This is a colourless volatile liquid hydrocarbon obtained by the distillation and rectification of coal-naphtha. The breathing of its vapour produces narcotic effects, but with some symptoms indicative of a noxious action on the brain and spinal marrow, *e.g.* noises in the head, convulsive trembling, twitchings of the muscles, convulsions, with difficulty of breathing. (See paper by Dr. Stone, 'Medical Gazette,' 1848, vol. 41, p. 1077.) But little is known concerning the action of liquid benzole on the human subject. It is poisonous to the lower animals and to all parasites; and it has been suggested by Dr. Sonnelkalb as a remedy for destroying the trichina spiralis (p. 343). This writer also refers to a case in which a quantity of liquid benzole was swallowed by a man, and it operated as a narcotic. ('Anilin und Anilinfarben,' Leipzig, 1864, p. 13.)

Analysis.—The odour and inflammability of the liquid, as well as its insolubility in water, are sufficient to identify it, and to allow of its separation from organic liquids.

Nitrobenzole.

This liquid, which is largely employed as a substitute for the essential oil of bitter almonds in perfumery and confectionery, has now taken its place among narcotic poisons. In the second edition of my work on Poisons (1859) some experiments were quoted from the Lancet (Jan. 10, 1857, p. 46), showing that one drachm of nitrobenzole killed a rabbit almost instantaneously; and half a drachm mixed with two drachms of water rendered a cat insensible for several minutes, a slimy mucus flowing from its mouth for several hours after-

wards. The animal refused all food, and died in twenty-four hours. ('ON POISONS,' 1859, p. 701.) In 1859, the late Professor Casper, of Berlin, published an account of this liquid under the name of 'A new Poison' (Vierteljahrsschrift,' B. 16, p. 1). Its effects on a rabbit and a dog are here described. Two drachms of it were given to a rabbit without any symptoms being produced; two drachms were then given to the animal at intervals of ten minutes or a quarter of an hour, until the animal had taken one ounce. In a minute and a half after the last dose, the animal fell suddenly on its left side. The pupils were dilated, while the limbs and tail were strongly convulsed. The animal died in a minute. The dose was probably unnecessarily large, but the result shows that nitrobenzole in a large dose destroys life rapidly. On opening the body, the powerful odour of the liquid was everywhere perceptible, even in the blood. This odour remained strongly in the body when it was again examined fourteen days after death. Twenty cubic centimetres (about five drachms) given to a middle-sized dog produced no remarkable symptoms. After some hours the animal was observed to be dull and languid: in twelve hours there was profound coma, with slow respiration and coldness of the skin; but there were no convulsions. The animal was then killed. All the solids and liquids of the body, including the blood, had a strong odour of the poison; and some drops of the oily liquid were separated from the contents of the stomach. The fluid on which it floated had a strong alkaline reaction. The blood retained the odour for several days.

Symptoms and Appearances.—Passing from experiments on animals to the effects produced on man, the following cases are of interest: they tend to show that, as in the action of chloroform and fusel-oil, the vapour is much more potent than the liquid. Mr. Nicholson ('Lancet,' Feb. 1, 1862, p. 135), in referring to a fatal case of poisoning by the liquid, states that he has known several instances in which the *vapour*, as it is evolved from almond glycerine soap, has seriously affected persons. A friend of his who used a cake of the soap in taking a warm bath fainted from the effects of the vapour of nitrobenzole set free, and was ill for some time afterwards. In July 1863, Mr. Fotherby communicated to me a case of poisoning by this compound, in which the symptoms so closely resembled those of essential oil of bitter almonds, that it was at first supposed this oil had been taken. A woman, æt. 30, tasted a liquid which had been used for flavouring pastry, and perceiving that it was very acrid on her tongue and lips, spat it out immediately and washed her mouth with water. She thought she could not have swallowed more than a drop, but in replacing the bottle she spilled about a tablespoonful on the table and did not immediately wipe it up. The vapour strongly impregnated the small room in which she was, and produced a feeling of sickness in another servant. The burning taste in the mouth was immediately followed by a sensation of numbness and tingling in the tongue and lips, and a strange feeling for the next hour. As the woman became worse, Mr. Fotherby was called in, and saw her in an hour and three-quarters after the occurrence. Her aspect was then quite typical of prussic acid poisoning:—the eyes were bright and glassy, the features pale and ghastly, the lips and nails purple, as if stained by blackberries; the skin was clammy and the pulse feeble. Her mind was then clear, and she described how the accident had occurred and what her sensations were. She was able to swallow a mustard emetic, after which she became rapidly worse, lost her consciousness, the teeth became set, the hands clenched and blue, the muscles rigid and convulsed. She vomited freely a pale fluid matter, which had the peculiar odour of nitrobenzole. The stomach-pump was used, but the fluid washed out of the organ had hardly any odour, owing probably to the small quantity actually swallowed, and its removal by absorption. The breathing became much reduced, and the pulse could scarcely

be felt. In about eleven hours there was reaction, consciousness returned, and she was able to swallow. At the end of seventeen hours she was much better; but she then complained of distorted vision, with flashes of light and strange colours before her eyes. For some weeks she continued weak. It was at first supposed the woman had swallowed a larger quantity of the liquid than she had imagined; but it is obvious, from the entire absence of the odour in the fluid drawn off by the stomach-pump, within about two hours, that but little could have passed into the stomach. There is no doubt, from what has been observed in other cases, that these severe symptoms were chiefly due to the breathing of the vapour in a concentrated form. A fellow-servant who was in the room at the time the nitrobenzole was spilled, also suffered from the inhalation of the vapour. Mr. Fotherby sent me a portion of the liquid, and I found it to be pure nitrobenzole unmixed with any essential oil of almonds.

A case of poisoning by this liquid which was the subject of an inquest at Ramsey, in the Isle of Man, is reported in the 'Pharmaceutical Journal' for December 1862, p. 283. A clerk in some chemical works took, on the 6th of November, a few drops (supposed to have been fifteen) of nitrobenzole. Immediately afterwards he felt unwell and became insensible. Stimulants restored consciousness, but there was a relapse, and he died the next day. The following case occurred at the London Hospital:—A boy, æt. 17, while drawing off some nitrobenzole by a siphon, swallowed a portion of the liquid. There were no immediate symptoms, but he soon felt sleepy, and when at dinner ate but little, and said he felt as if he was drunk. This was between two and three hours after he had swallowed the liquid. He fell into a stupor which became deeper and deeper until death took place, without vomiting or convulsions, twelve hours after the ingestion of the poison. (Dr. Mackenzie in 'Med. Times and Gaz.,' 1862, 1, 239.) The following cases occurred at Maidstone, in April 1865. A boy, æt. 13, applied a bottle containing nitrobenzole to his lips. No symptoms followed at the time, and the boy ate his dinner as usual. Some hours elapsed, when he suddenly became insensible. He was almost pulseless—his jaws were spasmodically closed: the skin of the face was purple, and the lips were livid. He died in about four hours after the seizure, and twelve hours after taking the poison. Some small quantity was most probably swallowed, as the contents of the stomach had a strong smell of the liquid. A cook in the same family also applied the bottle to her lips. It tasted bitter. She had her dinner as usual, but an hour after tasting the nitrobenzole she was seized with vomiting and felt very ill—her lips were black, and her face was purple and white. The woman recovered. The poison had been wrongly labelled oil of bitter almonds. For several cases of poisoning by this liquid see Husemann's 'Jahresbericht,' 1872, p. 531; and a paper by Dr. Schenk, Horn's 'Vierteljahrsschrift,' 1866, vol. 1, p. 32.

In a paper communicated to the Royal Society in 1863, Dr. Letheby describes two cases which fell under his observation. In one a man, æt. 43, spilled a quantity of nitrobenzole over his clothes, and went about several hours, breathing an atmosphere saturated with the vapour. The effects were nearly the same in both cases; although in one the poison was inhaled in vapour, and in the other it was swallowed as a liquid. For some time there was no feeling of drowsiness in the man; gradually, however, his face became flushed, his expression stupid, and his gait unsteady; he had the appearance of a person who had been drinking. The stupor gradually increased, until it passed into profound coma, and in this state he died. The progress of each of the fatal cases was much the same as that of slow intoxication, excepting that the mind was perfectly clear, until the coming on of the fatal coma. This was sudden, like a fit of apoplexy; and from that moment there was no return of con-

sciousness or bodily power: the sufferer lay as if in a deep sleep, and died without a struggle. The duration of each case was nearly the same. About four hours elapsed from the time of taking or inhaling the poison to the setting-in of the coma, and the coma lasted five hours.

The *appearances* after death were—flushed face and livid lips: the superficial vessels of the body, especially about the throat and arms, were gorged with blood, which was everywhere black and fluid. The dependent parts were turgid, the lungs somewhat congested; the cavities of the heart were full of blood; the liver was of a purple colour, and the gall-bladder distended with bile; the brain and its membranes were congested, and in the case of the man there was much bloody serosity in the ventricles. Nitrobenzole, as well as aniline, into which it appears to be partially converted in the body, was detected in the brain and stomach. ('Proc. Royal Soc. 1863,' No. 56, p. 550.) It is not stated what the result of the analysis, if any, was in reference to the case of death from the vapour, in which the poison was absorbed through the lungs. In performing some experiments on animals, Dr. Letheby found that the local action on the stomach was slight; there was rarely any vomiting, and there was either rapid coma, or a slow setting-in of paralysis and coma, after a long period of inaction. There was a complete loss of voluntary power, a spasmodic fixing of the muscles of the back, with violent struggles, a look of distress, and occasionally a kind of epileptic fit. The pupils were widely dilated, the action of the heart was irregular, and the breathing difficult. The time of death in the more rapid cases varied from twenty-five minutes to twelve hours after the administration of the poison. In other experiments, in which smaller doses were given, the time that elapsed between the administration of the poison and the coming-on of the first symptoms (an epileptic fit) varied from nineteen to seventy-two hours; in most cases it was about two days, and the time of death was from four to nine days. The appearances were similar to those already described. When death had taken place within twenty-four hours, the odour of the nitrobenzole was clearly perceptible in the stomach, brain, and lungs; and aniline (from the chemical conversion of nitrobenzole) was found in the organs. In the slower fatal cases the odour had often entirely disappeared; but traces of aniline could be detected in the brain and urine, and sometimes in the stomach and liver. Occasionally no trace of the substance was found, although death had taken place from the poison.

This narcotic compound differs from the ordinary narcotics in its powerful and persistent odour, which would render it difficult for a person to administer it, either in liquid or vapour, unknowingly to another; in the production of profound coma at an uncertain interval after the stupor; and in the rapidly-fatal effects when coma has followed. It operates powerfully as a poison in vapour as well as in a liquid state; but so far as cases have yet been observed in the human subject, the symptoms resembling those of the first stage of narcotic poisoning have very soon appeared. The rapidly-fatal cases only would be likely to be mistaken for apoplexy, but in these the poison would be detected by its odour.

Analysis.—Nitrobenzole or Essence of Mirbane is a pale lemon-coloured liquid of a strong odour resembling that of bitter almonds. It has a pungent hot disagreeable taste. It gives to confectionery the smell but not the pleasant taste of oil of bitter almonds. It destroys the colour of litmus, and gives a greasy stain to paper, leaving a yellow mark when the stain disappears. It sinks in water, and is partly dissolved, giving to it a yellowish colour. It is soluble in alcohol, ether, and chloroform; but when agitated with water, it is in great part separated from its ethereal and chloroformic solutions. It has no basic qualities; its aqueous solution is not precipitated either by tannic

acid or the chloriodide of mercury and potassium. It is highly combustible, burning with a yellow smoky flame. It yields no Prussian blue when mixed with sulphate of iron, alcohol, and potash, and its vapour produces no cyanide of silver with a solution of the nitrate. It is distinguished from all other liquids, excepting the essential oil of almonds, by its odour, and from this oil by the following test:—Pour a few drops of each on a plate and add a drop of strong sulphuric acid. The oil of almonds acquires a rich crimson colour with a yellow border, the nitrobenzole produces no colour. In order to separate it from organic liquids, they may be acidulated with sulphuric acid, and submitted to distillation in an apparatus similar to that which is described at page 264. If any of it exists in a free state, its odour will be sufficient for detecting its presence. If converted into aniline, another process will be required. There is no probability that this liquid will be successfully employed for the purposes of murder without the certainty of detection.

Aniline.

This is a narcotic poison in liquid or vapour resembling nitrobenzole in its toxicological effects. Schuchardt found that a small rabbit was killed by sixty drops in six hours and a quarter, and a large rabbit by one hundred drops in four hours. There was loss of sensibility with loss of heat, and violent clonic and tonic convulsions ensued which continued until death. From experiments hitherto performed, it does not appear to be an active poison as a liquid, and it seems to affect the spinal marrow more than the brain. It has also a local irritant action. Dr. Turnbull gave half a drachm of the sulphate to a dog. In two hours and a half the animal vomited, and an hour later it was purged. It became dull, weak, and tremulous; the pulse was rapid, and the breathing laboured. The feet were cold, the hind legs paralyzed, and the tongue was of a blue colour. In five hours the symptoms abated, and the next day the animal had recovered. ('Lancet,' Nov. 16, 1861.)

Dr. Letheby found that aniline given to dogs and cats in doses of from twenty to sixty drops, caused a rapid loss of voluntary power. The animal staggered and fell upon its side powerless, the head was drawn back, the pupils were dilated, the breathing was difficult, and the action of the heart tumultuous; there were slight twitchings or spasms of the muscles, and the animal quickly passed into a state of coma, from which it did not recover, death taking place in from half an hour to thirty-two hours. On inspection, the brain and its membranes were congested, the cavities of the heart were nearly full of blood, and the lungs but slightly congested. The blood all over the body was black and coagulated. The poison was easily discovered in the brain, the stomach, and the liver, although it was found that, as nitrobenzole is changed into aniline, so in some cases aniline and its salts are converted into mauve or magenta. This arises from the oxidation of the salts, and it has been especially observed on the surface of the body. ('Proc. Royal Society,' No. 56, 1863, p. 556.) There is no instance recorded of the effects of aniline as a poison on the human body. It is a liquid of nauseous odour and taste, and could hardly be taken or administered without the consciousness of the person taking it. The salts appear to have very little action. They have been used medicinally in large doses without producing any unusual effects. In one case 406 grains of the sulphate of aniline were given to a patient in the London Hospital, in the course of a few days, without any symptoms of poisoning. (Dr. Letheby, loc. cit. See also cases by Dr. Fraser, 'Med. Times and Gazette,' March 8, 1862, p. 239.) It is difficult to suppose that combination with an acid to form a perfectly soluble salt can render aniline inert, as this would be contrary to experience in reference to other bases, *e.g.* nicotina and conia: at the same

time, if we except the action of the vapour, no case of poisoning has occurred which will enable us to solve the question.

There are facts which show that the *vapour* of aniline, even when much diluted, exerts a noxious effect on man. Mr. Knaggs met with a case in which a workman accidentally broke a carboy containing a large quantity of this liquid; the aniline fell over him, but none entered his mouth. In his anxiety to wipe up the aniline, he respired the vapour for some time, felt giddy, and complained of his head and chest. When seen some hours after the accident his face and body were of a livid leaden hue, the lips, gums, tongue, and eyes of a corpse-like bluish pallor; he was breathing by gasping, and appeared at the point of death. There was no convulsion; he was sensible, and able to give a correct account of his feelings. His pulse was small and irregular. Under active treatment he recovered. ('Pharm. Jour.' July 1862, p. 42.)

Dr. Letheby relates the following case:—In June 1861, a boy, æt. 16, was brought into the London Hospital in a semicomatose condition. In scrubbing out an aniline vat he had breathed the vapour; and although he did not suffer pain or discomfort at the time, he was suddenly seized with giddiness and insensibility. When brought to the hospital he looked like a person in the last stage of intoxication; the face and surface of the body were cold, and the pulse was slow and almost imperceptible, the action of the heart was feeble, and the breathing heavy and laborious. After rallying a little, he complained of pain in his head and giddiness. His face had a purple hue, and his lips, the lining membrane of his mouth, as well as his nails, had a similar purple tint. On the next day the narcotic symptoms had passed away, but he was remarkably blue, and looked like a patient in the last stage of Asiatic cholera. These cases appear to show that aniline vapour is less poisonous than that of nitrobenzole, and that the symptoms follow more rapidly on the inhalation of the vapour. Dr. Kreuser, of Stuttgart, has noticed among the workers in aniline that they have suffered from intense bronchitis with a violent dry spasmodic cough, accompanied by ulcerations on the scrotum and extremities. The parts were swollen and painful, and covered with thick black crusts. This was obviously from want of cleanliness. ('Ed. Monthly Jour.' Aug. 1864, p. 172.) For a full account of the effects of aniline on animals, I must refer the reader to a pamphlet by Dr. Sonnenkalb, of Leipsic, 'Anilin und Anilinfarben in toxikologischer und medicinalpolizeilicher Beziehung,' Leipzig, 1864, p. 20. The injurious effects to public health likely to arise from the employment of aniline colours in confectionery and cosmetics, are also fully described in this essay. Some of the aniline dyes by contact with the skin have produced much irritation and sometimes an eczematous state. This subject has attracted much attention in Germany. (See Eulenberg's 'Vierteljahrsschrift,' 1871, 2, 325.) Many mineral substances of an irritant nature are used in the preparation of these dyes, and the articles are not always freed from them by washing.

Analysis.—Commercial aniline is an oily liquid of a reddish-brown colour, with a peculiar tarry odour. It produces a volatile greasy stain on paper. It is volatile and combustible, burning with a thick smoky flame. It falls to the bottom of water, and does not readily dissolve in it. It is quite soluble in alcohol and ether, but not in chloroform: in the latter property it differs from nitrobenzole. Diluted sulphuric acid combines with it to produce a white compound which is quite soluble in water. A solution of chloride of lime added to the acid watery liquid produces a splendid colour of various shades of purple and red.

The solution of sulphate of aniline is not precipitated either by tannic acid or chloriodide of mercury and potassium; but aniline itself, in the small quantity in which it is dissolved by water, yields, like the alkalies, a yellow preci-

pitate with arsenio-nitrate of silver. It also reduces completely a solution of chloride of gold—precipitating metallic gold. A minute quantity of aniline may be thus detected. When pure aniline is heated with powdered corrosive sublimate, it produces a rich crimson dye. When present in organic liquids, aniline may be separated by digesting the concentrated liquid in alcohol, mixed with a little diluted sulphuric acid. The alcoholic extract, distilled at a high temperature with a solution of potash, yields aniline in the receiver. This may be tested by the methods above described.

Oil of Wormwood. Absinthe.

I am indebted to Mr. W. Smith, surgeon to the Chesterfield Hospital, for the report of a case of poisoning by this oil, which, so far as I know, is the only instance on record of its noxious effects on man.

A druggist's shopman was found early one morning by his master, lying on the floor of the shop, perfectly insensible, convulsed, and foaming at the mouth. As the man had never suffered from fits, and the symptoms were of an alarming character, Mr. Smith was at once sent for. He found him no longer violently convulsed, but insensible; the jaws were clenched, and the pupils dilated. The pulse was weak, slow, and compressible. From time to time he uttered incoherent expressions, and attempted to vomit. With some difficulty Mr. Smith administered to him repeated doses of stimulants, sal volatile and water, lime water, and an emetic of mustard and sulphate of zinc. Free vomiting ensued, and consciousness partially returned. Artificial warmth was applied to the limbs, and a little brandy and water given at intervals, with draughts of milk and lime water. He gradually recovered. The matters vomited smelt strongly of oil of wormwood, and the nature of the poison was placed beyond doubt by the discovery of the bottle, with marks on its mouth of the oil having been recently poured out. The druggist stated that at least half an ounce had been taken. From the persistent smell of the oil in the ejected matters, after repeated vomiting, it is probable that this was even less than the real quantity. The man, on recovering, had totally forgotten all the circumstances connected with the case, and persisted in stating that he knew no reason why he should have taken it. It is, however, probable that he imagined himself suffering from worms, and sought relief in an unusual dose of this oil. (See 'Ann. d'Hyg.' 1863, 1, 227.)

A French liqueur called Absinthe appears to owe some of its properties to the presence of this oil, with a large proportion of alcohol. It has been much used in France, and its effects when taken in excess are those of a narcotic poison. According to Dr. Legrand it causes derangement of the digestive organs, intense thirst, restlessness, giddiness, tingling in the ears, and illusions of sight and hearing. These symptoms are followed by tremblings in the arms, hands, and legs, numbness in the limbs, loss of muscular power, delirium, loss of intellect, general paralysis, and death.

M. Magnan, who has had under his observation, since April 1869, two hundred and fifty patients more or less injured in health by the abuse of this intoxicating liquid, and who has besides performed numerous experiments on animals, states that epileptic convulsions are generally observed in these cases. Delirium tremens is the ordinary result of the abuse of alcohol, but the epileptic attacks are specially referable to the absinthe. Magnan describes it as 'absinthe epilepsy.' (Husemann's 'Jahresbericht,' 1872, p. 499, and Bouchardat's 'Annuaire de Thérapeutique, 1872, p. 66.)

Analysis.—One sample of this liquid which I examined had a greenish colour, an aromatic odour like that of aniseed, and a hot pungent bitter taste. A large quantity of alcohol was obtained by the distillation of it. It acquired a milky appearance on the addition of water, owing to the separation of essen-

tial oil. It is a strong alcoholic mixture of oil of aniseed, oil of wormwood, and other aromatic substances.

NITROGLYCERINE (GLONOINE).

This is a powerfully explosive liquid, well known to chemists as a substitution-compound of the innoxious liquid glycerine, obtained in the process of saponification. It has a sweet aromatic pungent taste, and it is stated that a single drop placed on the tongue produces a painful aching in the back of the head which lasts for some hours. ('Miller's Chemistry,' vol. 3, p. 277.) Mr. Field states that he found one drop of the liquid dissolved in water produced insensibility and other symptoms of narcotic poisoning. ('Chem. News,' Nov. 7, 1863.)

Symptoms and Appearances.—In Sweden this liquid is much used in mining under the name of 'blasting oil.' Within the last four years ten cases of poisoning by it have occurred in that country. In these cases, the oil appears to have been taken in quantity (some ounces). In some instances it proved rapidly fatal. In a recent case a miner swallowed two mouthfuls. A painful feeling in his throat made him aware of his mistake, and he drank a quantity of milk. He was not seen by a medical man for an hour and a quarter. He was then suffering from faintness, difficulty of breathing, and oppression at the chest. In five hours vomiting and purging set in. Shortly before death the man lay quietly as if asleep, breathing feebly and occasionally with a deep sigh. The lips were livid before death. On inspection there was great congestion of the membranes of the brain as well as of the lower lobes of the lungs. The mucous membrane of the air-passages was of a red-brown colour. The greater end of the stomach presented a similar appearance with ecchymosis. (Husemann's 'Jahresbericht,' 1872, p. 533.)

According to Mr. Merrick, the vapour of this liquid acts powerfully as a narcotic poison, and even when much diluted with air it produces intense headache. Other experimentalists have not observed these extraordinary effects, and are inclined to regard it as inert, or at any rate they consider that its narcotic properties have been greatly exaggerated. Some support has been given to this last opinion by the fact that the liquid has been used by homœopathists under the name of glonoine, and the effects said to have been produced by infinitesimal doses are of so marvellous a character as to justify utter incredulity. Like other liquids described in this chapter, it probably acts most powerfully by its vapour, but further observations of a trustworthy kind are required to determine its potency as a poison.

Professor Vrij, of Rotterdam, has prepared nitroglycerine in large quantities, and has examined its chemical and physiological properties. Sobrero, who discovered it in 1847, stated that the smallest quantity was sufficient to produce the most violent headache, and he concluded from this that it was a powerful poison. Professor Vrij found that the vapour caused intense headache, but that it had no poisonous properties. He gave two drops to a rabbit, and no symptoms of poisoning were produced. ('Pharm. Journal,' 1855–6, p. 229.)

Analysis.—Nitroglycerine is a heavy oily-looking liquid. It is dissolved by water, but is insoluble in alcohol and ether. It explodes violently when struck or subjected to concussion.

CHAPTER 29.

ALCOHOL—ETHER—HYDRATE OF CHLORAL—CHLOROFORM—CAMPHOR—TOBACCO—NICOTINA—COCCULUS INDICUS—PICROTOXINE—DARNEL SEEDS—CALABAR BEAN—FUNGI—HENBANE—LACTUCARIUM—SOLANUM.

ALCOHOL.

Symptoms.—In general, the symptoms produced by alcohol come on in the course of a few minutes. There is confusion of thought, with inability to stand or walk, a tottering gait, and giddiness followed by stupor and coma. Should the person recover from this stage, vomiting supervenes. The insensibility produced by alcohol may not come on until after a certain period, and then suddenly. Sir R. Christison met with an instance in which a person fell suddenly into a deep stupor, some time after he had swallowed sixteen ounces of whisky—there were none of the usual premonitory symptoms. In another instance, a person may apparently recover from the first effects, and then suddenly become insensible and die convulsed. There is a ghastly or vacant expression in the face, which is sometimes suffused and bloated; the lips are livid, and the pupils are dilated and fixed; if they possess the power of contracting under the influence of light, it is a favourable sign. (See case in 'Lancet,' Jan. 27, 1855, p. 89.) The conjunctivæ or whites of the eyes are generally much suffused. The breath has an alcoholic odour. The more concentrated the alcohol, the more rapidly are the symptoms induced, and they are also more severe in their character. Diluted alcohol commonly produces a stage of excitement before stupor, while in the action of concentrated alcohol there may be profound coma in a few minutes. The cause of death may be generally traced to congestion of the brain or lungs, or both. Alcohol may act as a poison by its *vapour*. If the concentrated vapour be respired, it will produce the usual effects of intoxication. There is a case on record in which a child two years of age was thrown into an apoplectic stupor by the alcoholic vapour of eau de Cologne. In this manner a child might be destroyed, and no trace of the poison found in the stomach. In four years (1863-7) thirty-five deaths are reported to have occurred from alcohol in the acute form of poisoning in England and Wales.

The symptoms arising from apoplexy, from concussion of the brain, or the effects of opium, have been sometimes mistaken for those of poisoning by alcohol, and persons have been wrongly charged with being drunk. With respect to *concussion*, a difficulty can arise only in reference to the more advanced stage of poisoning by alcohol, *i.e.* in which there is profound coma. Intoxication may in general be easily distinguished by the odour of the breath, for so long as the symptoms continue, the alcohol is eliminated by the lungs. If there should be no perceptible odour of any alcoholic liquid, the presumption is that the symptoms are not due to intoxication. When the alcoholic odour is perceptible, the symptoms may still be combined with the effects of apoplexy or concussion—a fact which can be cleared up only by a history of the case, or a careful examination of the head for marks of violence. In poisoning by *opium* there will be a strong smell of this drug in the breath, the symptoms come on much more gradually, and are marked by drowsiness and stupor, passing into complete lethargy, with general relaxation of the muscles, and inability to walk. In poisoning by alcohol there is either great excitement some time before the stupor, which comes on suddenly, or the person is found in a state of deep coma a few minutes after having taken the poison. In poisoning by opium the face is pale, and the pupils are contracted:—in poisoning

by alcohol the face, under excitement, is more commonly flushed, and the pupils are generally dilated. Another fact to be noticed is, that while perfect remissions are rare in poisoning by opium, in poisoning by alcohol a person frequently recovers his senses and dies subsequently. When coma has supervened, the patient may be roused by a loud noise or a violent shock in either case, and it is very difficult under these circumstances to draw a well-marked distinction. The odour of the breath, or an examination of the fluid drawn from the stomach by the pump, may then show which poison has been taken: but the treatment is the same in both cases.

Appearances.—The stomach has been found intensely congested or inflamed, the mucous membrane presenting in one case a bright red, and in another a dark red-brown colour. When death has taken place rapidly, there may be a peculiar odour of spirits in the contents; but this will not be perceived if the quantity taken was small, or many hours have elapsed before the inspection is made. The brain and its membranes are found congested, and, in some instances, there is effusion of blood or serum beneath the inner membrane. In a case observed by the late Dr. Geoghegan, in which a pint of spirits had been taken, and proved fatal in eight hours, black extravasation was found on the mucous membrane of the stomach; but no trace of alcohol could be detected in the contents. ('Dub. Med. Press,' i. 293.) The action of a strong alcoholic liquid on the mucous membrane of the stomach so closely resembles the effects produced by arsenic and other irritants, as easily to give rise to the suspicion of mineral irritant poisoning. A drawing in the Museum collection of Guy's Hospital, furnishes a good illustration of the local action of alcohol. The whole of the mucous membrane of the stomach is highly corrugated, and is of a deep brownish-red colour. Of all the liquids affecting the brain, this has the most powerful local action on the stomach. A case of alcoholic poisoning of a child, æt. 7, referred to me by Mr. Jackaman, coroner for Ipswich, in July 1863, will serve to show the correctness of this remark. A girl was found at four o'clock in the morning lying perfectly insensible on the floor. She had had access to some brandy which she had swallowed from a quartern measure found near her quite empty. She had spoken to her mother only ten minutes before, so that the symptoms must have come on very rapidly. She was seen by Mr. Adams four hours afterwards. She was then quite insensible, in a state of profound coma, the skin cold and covered with a clammy perspiration. There had been slight vomiting. The child died in twelve hours, without recovering consciousness from the time at which she was first found. On inspection, there was congestion of the brain and its membranes: the heart and lungs were quite healthy. The mucous membrane of the stomach presented patches of intense redness, and in some places it was thickened and softened; portions of it were detached and hanging loosely in the stomach; and there were patches of black extravasation about it, evidently from altered blood. It contained a greenish-coloured liquid, but there was no smell of brandy in it, neither was this perceptible in the breath of the child, four hours after the alcoholic liquid had been taken. At first it was suspected that arsenic had been administered, but the symptoms were not those of arsenical poisoning, and neither arsenic nor any other metallic irritant was present in the contents of the stomach, but slight traces of the vapour of alcohol were detected by the process described below.

Analysis.—When a large dose has been taken and the case has proved rapidly fatal, the contents of the stomach may have the odour of alcohol, or of the alcoholic liquid taken. The odour is not always perceptible, or it may be concealed by other odours. In a case of poisoning by gin, the liquid drawn from the stomach by the pump after seven hours had no odour. In the case of the child above related, the smell of brandy had entirely disappeared in

twelve hours. The whole of the contents or of the suspected liquid should be distilled in a water-bath, with a proper condensing apparatus attached. If the liquid has an acid reaction, it should be first neutralized by a solution of carbonate of potash or soda. The watery liquid obtained should be mixed with fused chloride of calcium or anhydrous sulphate of copper in sufficient quantity, and submitted to a second distillation in a smaller retort, by a water-bath. The liquid resulting from the second distillation should be agitated with rather more dry carbonate of potash than it will dissolve, in a small tube provided with a stopper, and allowed to stand. A stratum of alcohol, if present, will, after a time, float on the surface, and may be drawn off by a pipette and examined. *Tests.*—1. Alcohol has a hot pungent taste, a peculiar odour, and is very volatile. 2. Absorbed in asbestos, it burns with a pale blue flame, which deposits no carbon on white porcelain; and when burnt in the mouth of an inverted test-tube, containing a few drops of solution of baryta, it produces a well-marked deposit of white carbonate of baryta. Lime water may be substituted for baryta in this experiment. Carbonic acid and water are the sole products of its combustion. 3. It dissolves camphor. 4. It sets free green oxide of chromium when boiled with a few drops of a saturated solution of bichromate of potash mixed with sulphuric acid. (Dr. Thomson, in 'Monthly Jour. Med. Science,' Dec. 1846, p. 412.)

The following method will allow of the detection of a quantity of alcohol too small for separation by the process above mentioned. Make a mixture of strong sulphuric acid and a saturated solution of bichromate of potash: moisten with this mixture a few fibres of asbestos, and inclose them in a glass tube connected with the retort or flask in which distillation is carried on. For this purpose a flask or tube similar to those used for the detection of chloroform vapour will be found serviceable (see p. 391). The smallest portion of alcohol-vapour passing over the asbestos, immediately renders it green, by converting the chromic acid to oxide of chromium. This may serve as a trial test or for evidence, according to circumstances. The tube may be removed, and the condensed vapour collected for the application of the other tests. Ether and pyroxylic spirit produce a similar result.

From lapse of time, the effects of treatment, or absorption and elimination, there may be no trace of alcohol in the stomach or intestines, nevertheless the person may have died from the effects. In a case, fatal in eight hours, which occurred to the late Dr. Geoghegan, no alcohol was found in the stomach (p. 385). One cause of failure may sometimes be traced to the distillation being restricted to a portion of the contents. It is advisable to distil the *whole*, as, if necessary, the distillate or the residue can be examined for other poisons.

ETHER.

Symptoms and Effects.—Ether, in moderate doses, has a hot burning taste, and produces during swallowing a sense of heat and constriction in the throat. It causes, like alcohol, great excitement and exhilaration, followed by intoxication, but persons may become habituated to it, and thus after a time it may be taken in very large quantities with comparative impunity. It causes intoxication more rapidly, but this state is of shorter duration with ether than it is with alcohol. In the north of Ireland it is said to have been much used of late years as a substitute for whisky. The effects produced on the system, when a large dose has been taken, are not unlike those occasioned by alcohol. Orfila found that about half an ounce of sulphuric ether, administered to a dog, caused, in a few minutes, a disposition to vomit. This was followed by giddiness, and in ten minutes by an entire loss of power in the muscles. The breathing was painful and hurried, but there were no convulsions. After a slight abatement in the symptoms, the dog fell into a state of insensibility, and died in three

hours. The whole of the mucous membrane of the stomach was of a blackish-red colour, and with the other coats intensely inflamed. There was slight inflammation of the duodenum; but the rest of the alimentary canal was in a healthy condition. The heart contained black blood partly coagulated: the lungs were gorged with fluid blood. (Op. cit. ii. 531.) Ether as a liquid has not, so far as I know, destroyed life; but when its vapour has been breathed, it has caused death in several instances. (See 'ON POISONS,' 2nd ed. p. 731.)

Analysis.—When ether has been taken as a liquid and has caused death, it may be separated from the contents of the stomach by the process described for alcohol. The chromic acid process (see Alcohol) applied to the vapour during distillation will enable the analyst to detect a minute quantity; and, by its peculiar odour, ether may be easily distinguished from alcohol or pyroxylic spirit. 1. Ether is highly inflammable, and burns with a yellow smoky flame, producing carbonic acid and water. 2. When shaken with its bulk of water, only a small portion is dissolved, the rest floats on the surface. If taken in a liquid form, it may be separated from the contents of the stomach by distillation, and the product rectified by redistillation with dry carbonate of potash at a temperature of about 120°.

HYDRATE OF CHLORAL.

This is a solid crystalline substance produced from the reaction of chlorine on alcohol, and the subsequent addition of a small quantity of water. It has been much used of late as a substitute for opium, and in doses of twenty to thirty grains it has been found to operate as a sedative and narcotic without producing any stage of excitement. It has been given in very large doses, sometimes with benefit, but at other times causing dangerous symptoms, followed by death. Medical men who have taken it incautiously have died from its effects. Two instances of this kind are reported in the 'Med. Times and Gaz.' (1871, 1, 367). The deaths have been frequently sudden, and no remarkable symptoms have preceded dissolution. The person has passed from sleep into death.

Symptoms and Appearances.—According to Liebreich, who introduced this compound, it produces in proper doses, after a short interval, a deep sleep, and, when carried far enough, complete loss of consciousness and sensibility. A lady took six doses of thirty grains each. She fell into a sound sleep. Every attempt failed to arouse her, and she slept into death. The principal post-mortem appearance was great congestion of the cerebral vessels. ('Med. Times and Gaz.' 1871, 1, 132.) In another case a lady took in three doses at intervals of four hours, seventy grains of the hydrate. In two hours after the last dose, she suffered from severe cramps in the legs, a feeling of suffocation, swimming in the head, and inability to regulate her movements. Four hours after the last dose her face was flushed, the eyelids were closed, and the conjunctivæ injected; the pulse was quick (120) and bounding. She was with difficulty roused either to speak or take food. She recovered in about sixteen hours. ('Med. Times and Gaz.' 1870, 2, 435.)

A patient under Dr. Habershon at Guy's, took half a drachm of the hydrate at night. He became unconscious almost immediately after swallowing the draught—the face and hands turned livid and cold, and breathing took place only at long intervals, indeed for about five hours death seemed to be impending. He recovered next day. ('Lancet,' 1870, 2, 402.) A case is reported in the same journal in which a dose of 160 grains was given by mistake to an hospital patient, a middle-aged man. The man slept well and recovered, notwithstanding the large dose taken. Dr. N. Smith, of Baltimore, met with two cases in which sudden death followed ordinary doses, and in one instance a drachm and a half thrown in by the rectum produced rapidly insensibility and caused death in three hours. ('Lancet,' 1871, 2, 466.) It has been observed,

in reference to this drug, that in the sleep produced by it the pupil is contracted, but that it immediately dilates on the person awaking. In other cases the pupil has been dilated and insensible to light. There appears to be considerable uncertainty in the action of this drug, even when similar doses are given. After an ordinary dose of twenty or thirty grains a patient has slept for a quarter of an hour, and has then awakened with a sense of deadly faintness, the lips livid, the face pale, the pulse scarcely perceptible, and a feeling of intense exhaustion and impending dissolution, mingled with delirium, lasting for five or ten minutes. It appears to exert a depressing action on the heart, and in cases of heart-disease it may thus cause sudden death ('Lancet,' 1871, 2, 32). One case proved suddenly fatal by causing paralysis of the heart ('Lancet,' 1871, 1, pp. 227, 440, 473).

Fatal dose.—A dose of thirty grains proved fatal in thirty-five hours to a young lady, æt. 20; while in a case mentioned above a man recovered from a dose of 160 grains taken at once. Dr. Fuller states that one of his patients took 150 grains and another 180 grains without injury. ('Lancet,' 1871, 1, 403. See also Husemann's 'Jahresbericht,' 1872, p. 509.) Dr. Richardson states that the largest dose which he has known to be taken was 120 grains. It produced prolonged and dangerous coma, but recovery followed. He looks upon this as a safe dose for an adult, distributed over twenty-four hours in divided quantities. Taken at once it is a maximum dose for an adult, dangerous, but not necessarily fatal. Beyond 120 grains the danger increases, and 180 grains may be considered a dose that would prove, in the majority of cases, positively fatal. ('Med. Times and Gaz.' 1871, 1, 169.)

The mode in which it is supposed to destroy life when absorbed, is by its conversion in the blood into chloroform and formic acid, by reason of the alkaline nature of this liquid. The presence of chloroform has been demonstrated in the blood of dogs to which chloral had been administered (Wiggers' 'Jahresbericht, 1871, p. 566.)

Analysis.—The hydrate of chloral is a white brittle crystalline solid, of a peculiar odour and a pungent bitter taste. When heated on platinum it melts and is entirely volatilized without combustion, unless turned into the flame. It is not inflammable. Heated in a close tube it melts and does not rapidly solidify. It is distilled over in a liquid form, and after a time it sets into groups of crystals in the glass tube. It is soluble in water, which retains it on cooling, while the alcoholate is again in great part deposited. The solution is not acid, has no bleaching properties, and gives only a faint milkiness on boiling with a solution of nitrate of silver. It is dissolved by strong sulphuric and nitric acids, without any change of colour. Potash added to the solution while boiling converts it instantly into chloroform which escapes in copious effervescence, and into formic acid, which combines with the alkali. On boiling it with potash the solution, if the hydrate is pure, acquires only a slight yellow colour. When boiled with chloride of gold or nitrate of silver, and potash is added, gold or silver is immediately precipitated. It decomposes a salt of copper like grape sugar, but in the cold potash does not redissolve the precipitated oxide of copper.

According to Attfield, 100 parts will yield 82 parts of chloroform. It is by this conversion that hydrate of chloral may be detected in the contents of the stomach. The liquid should be rendered alkaline with potash, and the mixture heated in a flask by a water-bath. The vapour which escapes may be tested for chloroform by the process described at p. 391. Dr. Procter, of York, thus detected it in a case of suicidal poisoning.

CHLOROFORM.

Symptoms and Appearances.—This liquid, when taken in a large dose, appears to affect the system like alcohol: but as a *liquid* it cannot be regarded

as an active poison. I have elsewhere recorded a case communicated to me by Mr. Jackson, of Sheffield, in which a man swallowed *four ounces* of chloroform. He was able to walk for a considerable distance after taking this dose, but he subsequently fell into a state of coma—the pupils were dilated, the breathing was stertorous, the skin cold, the pulse imperceptible, and there were general convulsions. He recovered in five days. ('Med. Gaz.' vol. 47, p. 675.) A private in a cavalry regiment in the United States swallowed nearly two ounces of chloroform. He was seen ten or fifteen minutes afterwards; he had already vomited, and was found insensible with stertorous breathing, and a pulse of about 60. The stomach-pump was employed, and some spirits of ammonia were injected. The pulse became more feeble, the breathing slower, and the pupils were insensible to light. The surface was cold, and for a time he continued to get worse, the face becoming purple, while the pulse was intermittent and hardly discernible. Two hours and a half after taking the poison, however, a gradual improvement commenced, but sensibility did not return until four hours later. For several days he continued to suffer from great irritability of the stomach, and eventually he had an attack of jaundice. ('Amer. Journ. Med. Science,' Oct., p. 367; 'Med. Times and Gazette,' Nov. 28, 1857, p. 558.) A man, æt. 42, swallowed two ounces of liquid chloroform, and he died in about six hours afterwards. In this case the pupils were fully dilated, the breathing was stertorous, and the skin covered with a cold perspiration. He rallied for a short time and then sank again, his lips becoming dark purple and his face livid. On inspection the lungs were found much engorged with blood, and there were some apoplectic effusions in these organs. The stomach was slightly inflamed in patches, and the mucous membrane was softened. It contained a dark fluid smelling strongly of chloroform ('British Med. Jour.' May 1866, and 'Amer. Jour. Med. Sci.' Oct. 1866, p. 571.) It has been generally observed that in death from chloroform-vapour all the cavities of the heart are distended, and the cases are exceptional in which the left side is empty. The right cavities usually contain more blood that those of the left. ('Ed. Monthly Journal,' 1864, p. 186. See also Husemann's 'Jahresbericht,' 1872, p. 502.) In two cases, alarming symptoms have been produced by much smaller doses, and one of these proved fatal. In March 1857, a lady swallowed half an ounce of pure chloroform. In five minutes she was quite insensible, generally convulsed, the jaws clenched, the face slightly flushed, the pulse full and rather oppressed, and she foamed at the mouth. She vomited, and in twenty minutes the convulsions had left her; soon afterwards she had a relapse, and did not recover for twenty-four hours. ('Med. Times and Gaz.' Dec. 12, 1857, p. 615.) The symptoms in this case appear to have been mixed with those of hysteria and epilepsy. In another case a lady also took half an ounce of liquid chloroform. An emetic was given, and in a few minutes a large quantity of liquid was thrown off the stomach. In about an hour the patient became suddenly livid and then blanched in the face. The pulse was thready and scarcely perceptible—the breathing slow, and after a time stertorous; the hands and face became purple, the eyes were deeply suffused and the pupils were dilated. There was mucous vomiting at intervals. The patient was quite insensible—the eyes were fixed and the face flushed. She appeared to be dying, but under treatment these symptoms passed away, and in about two hours sensibility returned and she recovered. ('Lancet,' 1870, 1, 290.) The following case was communicated to me by Mr. Thursefield, of Broseley, in March 1854. A boy, æt. 4, was brought to him by his father in a state of total insensibility. It appears that he had swallowed a *drachm* of chloroform, and soon afterwards laid his head on his mother's lap and lost all consciousness. Mr. Thursefield saw him about twenty minutes afterwards. He was then insensible, cold, and pulseless. Mustard plasters were applied to the legs; they acted well, but pro-

duced no impression on the sensibility. His breathing varied; it was sometimes natural, at other times stertorous. He became warmer, his pulse full and regular; and he continued *three hours* in this state, when he died quite calmly without a struggle, in spite of every effort made for his recovery. This is the smallest dose of liquid chloroform that has destroyed life.

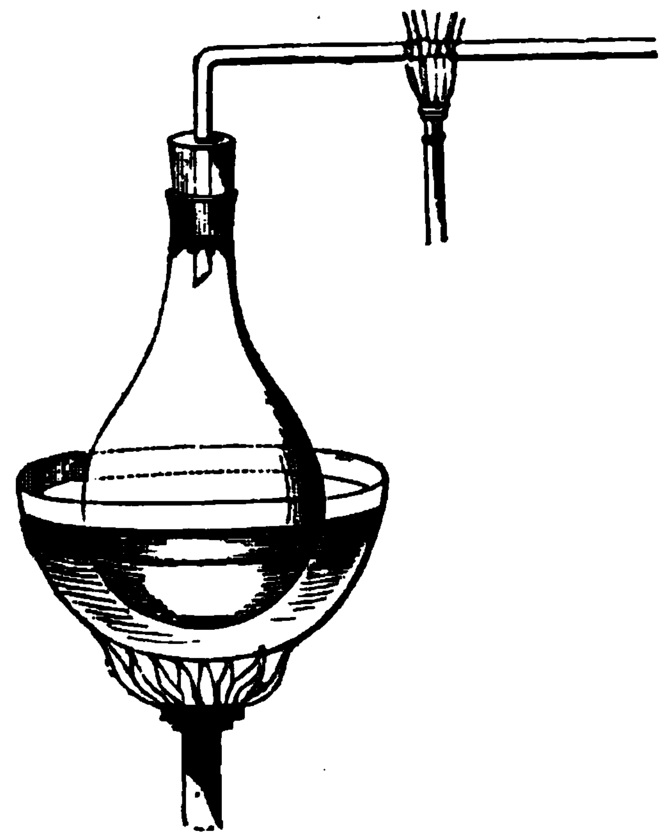
Chloroform-vapour.—The vapour, when respired in a concentrated form, is speedily fatal to life. If it is diluted with a certain proportion of air, it produces insensibility, with entire loss of muscular power in from eight to ten minutes, and the patient rapidly recovers after the vapour is withdrawn. Cases of death from the inhalation of the vapour for surgical purposes are now very numerous, and the symptoms and post-mortem appearances are well-marked. (See 'On Poisons,' 2nd edit. p. 738; 'Lancet,' April 16, 1859, p. 400, and April 23, p. 425; also 'Lancet,' 1870, 2, 454 and 886.) In some instances death has taken place within two minutes from the commencement of inhalation. In one of these only thirty drops had been taken in vapour, but the patient died in one minute, and in another, so small a quantity as fifteen or twenty drops proved speedily fatal. ('Table of Fatal Cases' by Dr. Warren, U.S. p. 23.) Chloroform, therefore, operating through the lungs has destroyed life more rapidly, and in a smaller dose, that any other poison known. The late Sir J. Simpson has suggested that in some of the alleged fatal cases death may have been really due to other latent causes of sudden death. ('Med. Times and Gaz.' 1870, 1, 224.)

Its fatal operation is sometimes suddenly manifested after the withdrawal of the vapour, apparently by an accumulative effect on the blood. In one case witnessed by a friend, the heart suddenly ceased to beat four minutes after the vapour had been withdrawn. The digital arteries which had been divided in the operation suddenly ceased to bleed. The man was dead. The fatal effects are generally ascribed to idiosyncrasy or to the unforeseen condition of a fatty or flabby heart. Admitting this to be to some extent the true cause of the fatality, it cannot be denied that fatty and flabby hearts have become very common, since the introduction of chloroform-vapour for surgical and other purposes! In cases of alleged robbery and rape, it has been sometimes stated that the person assaulted was rendered suddenly insensible by chloroform: but chloroform-vapour does not produce immediate insensibility, unless it also produces asphyxia and death. Dr. Stevenson found that in more than two hundred cases of its administration at Guy's Hospital, adults were not commonly rendered insensible until after the lapse of eight minutes; the dose being three-and-a-half drachms given in half-drachms. In March 1863, a woman, æt. 40, took ten drachms in thirty-three minutes, in half-drachm doses, and was still conscious and able to talk. According to the report of a committee, the average amount of the vapour to act safely as an anæsthetic is $3\frac{1}{2}$ per cent., the maximum being $4\frac{1}{2}$ per cent. It should be only slowly and never suddenly increased. It should never be given after a long fast, and never in the sitting or erect posture. ('Edinburgh Monthly Journal,' 1864, p. 187.) It is also stated, as the result of observation, that from two to ten minutes are required to induce insensibility. The time, however, varies with age, temperament, and habits.

Analysis.—Chloroform is a heavy colourless liquid (sp. gr. 1·484), neutral in its reaction, sinking in water in globules, and only to a slight extent dissolving in that liquid. It has a fragrant odour like that of apples; it is dissolved by alcohol and ether. A solution in alcohol, in the proportion of one part by measure to nineteen parts of rectified spirit, forms the *Spiritus Chloroformi*, or, as it is sometimes called, Chloric Ether. Chloroform is highly volatile, but its vapour is not inflammable and not readily combustible. Like alcohol it dissolves camphor readily. Nitric and sulphuric acids produce no change in it. It boils at 140°, and evolves a vapour which at a red heat is

resolved into chlorine and hydrochloric acid. On this effect a process has been suggested for separating it from the *blood and tissues*, when it has proved fatal in the form of vapour. The substance supposed to contain chloroform is placed in a flask, like that shown in the annexed illustration. The neck of the flask is fitted with a cork perforated to admit a hard glass tube, bent at right angles, and having a length of from twelve to fifteen inches. The flask is gradually plunged into water at about 160°, and at the same time the middle portion of the tube is heated to full redness by an air-gas jet. At a red heat chloroform vapour is decomposed, and chlorine and hydrochloric acid are among the products of its decomposition. Litmus paper applied to the mouth of the tube is reddened: starch paper wetted with iodide of potassium is rendered blue, and nitrate of silver is precipitated white. Two drops of pure chloroform were thus readily detected, and so persistent was the vapour in the closed vessel, that it was detected after one, two, and even three weeks. Two drops added to a quantity of putrefied blood were detected by a similar process after a fortnight, the flask being closed, but the mouth of the tube remaining exposed to air. This method of detecting chloroform by its products appears to be quite satisfactory. In practice, however, it will be found a very difficult matter to detect it, even where we know it has been administered. Some years since, in conjunction with the late Dr. Snow, I examined by this process the blood of a boy who had died in Guy's Hospital from the effects of chloroform-vapour, but without detecting any trace of it. There was no odour in the blood, and the result was negative. In 1863, I examined the blood of three persons, taken while they were under the full operation of chloroform, and collected in closely-stopped glass bottles. One of the samples, examined within half an hour after removal from the living body, had no odour of chloroform, and gave not the slightest indication of its presence. The two other samples, kept in close bottles until tested, forty-eight hours after removal, did not contain a trace of chloroform-vapour. Either the quantity in a few ounces of blood is too small for detection, or it is rapidly lost by its volatility, or it is converted in the blood into formic acid or some other product.

Fig. 50.



Apparatus for the detection of the vapour of Chloroform.

As chloroform is much more volatile than ether, and its odour is not so pungent, it is not so easily detected in the dead body by the smell. The body should be inspected as soon as possible, and any solids or liquids intended for examination should be kept in well-closed glass vessels. If the smell can still be perceived in the blood or organs, the vapour may be easily detected by the method above described. Chloroform, if not eliminated or lost by its volatility, may have been converted in the blood into formic acid, and thus removed from the ordinary processes of chemistry.

Camphor.

There are but few instances recorded in which camphor has proved fatal in the human subject; but it has on several occasions produced alarming symptoms, and would probably have destroyed life, had it not been early removed from the stomach. In the few cases that have been observed, its effects were somewhat different.

Symptoms and Appearances.—Camphor operates on the brain and nervous system. A woman swallowed about *twenty grains* of camphor dissolved in rectified spirits of wine mixed with tincture of myrrh. In half an hour she was suddenly seized with languor, giddiness, partial loss of sight, delirium, numbness, tingling and coldness of the extremities, so that she could hardly walk. The pulse was quick and respiration difficult, but she suffered no pain in any part. On the administration of an emetic, she vomited a yellowish liquid smelling strongly of camphor. In the evening the symptoms were much diminished, but she had slight convulsive fits during the night. The next day she was convalescent; the difficulty of breathing, however, continued more or less for several weeks. This is the smallest dose of camphor which appears to have been attended with serious symptoms in an adult. In January 1863, an infant of fifteen months died from the effects of some camphorated oil given to it by mistake. Convulsions ensued, and death took place in thirteen hours. Three cases of poisoning by camphor are reported by Dr. Schaaf, one of which proved fatal. A woman gave about thirty grains (half a teaspoonful) of powdered camphor to each of her three children as a vermifuge. Two of the children were respectively of the ages of three and five years; the third was an infant aged eighteen months. The first symptoms were paleness of the face with a fixed and stupid look. Delirium followed, with a sense of burning in the throat, and great thirst. Vomiting, purging, and convulsions supervened, and in one child the convulsions were most violent. The two elder children, after suffering thus for three hours, fell into a comatose sleep, and on awaking the symptoms passed off. The infant died in seven hours, not having manifested any return of consciousness from the first occurrence of convulsions. ('Journal de Chimie Médicale,' 1850, p. 507.) The severity of the symptoms is fully explained by the large quantity administered and the age of the children. In a dose of one drachm given in a clyster, camphor produced alarming symptoms. ('Med. Gaz.' vol. 48, p. 552.) In a case reported in the 'Medical Gazette' (vol. 11, p. 772), 120 grains were taken by a physician, and all that he experienced was lightness in the head with great exhilaration. There was no derangement of the stomach or bowels. He slept profoundly for some hours, and awoke very weak and exhausted. He also perspired greatly during his sleep. It is difficult to draw any conclusion from this case, as the quantity taken was conjectural, and the patient was not seen by any person while labouring under the effects of the poison. A soldier took a large quantity of camphor daily. For three days it had no effect upon him. On the fifth day he suffered from great pain and a burning sensation in the stomach. His head was painful: there was giddiness, with an incessant desire to walk about, although, like a drunken man, he could hardly keep on his legs. He soon fell completely insensible—his limbs were cold, his face was pale, his body convulsed, and the pupils were dilated. These symptoms were followed by an irresistible desire to sleep. In two or three days he recovered. ('Med. Times and Gaz.' Dec. 1858, p. 645.)

A case of poisoning by camphor would be recognized by the odour of the breath, a symptom which would attract the attention of a non-professional person. The presence of this substance in the stomach would be at once indicated by its odour.

TOBACCO.

Symptoms.—The effects which this substance produces, when taken in a large dose, either in the form of powder or infusion, are well-marked. The symptoms are faintness, nausea, vomiting, giddiness, delirium, loss of power in the limbs, general relaxation of the muscular system, trembling, complete prostration of strength, coldness of the surface with cold clammy perspiration,

convulsive movements, paralysis, and death. In some cases there is purging, with violent pain in the abdomen; in others there is rather a sense of sinking or depression in the region of the heart passing into syncope, or creating a feeling of impending dissolution. With the above-mentioned symptoms there is dilatation of the pupils, dimness of sight, with confusion of ideas, a small, weak, and scarcely perceptible pulse, and difficulty of breathing. A woman applied some leaves of tobacco to ulcers upon her legs. After some hours she suffered from sickness, dimness of vision, and cramps in the legs, with great prostration; she also complained of a benumbed feeling. On the third day there was great sleepiness, with headache and an irregular action of the heart. In about a week, she recovered her usual health. ('Lancet,' 1871, 2, 663.) Dr. Namias relates an instance of a smuggler being poisoned by reason of his having covered his skin with tobacco-leaves with a view of defrauding the revenue. The leaves, moistened by perspiration, produced all the effects of poisoning. The pulse was small and feeble; there was faintness attended with cold sweats. The operation of the poison seemed to be principally on the heart. M. Decaisne has observed in persons who have smoked tobacco excessively, a sedative action on the heart, indicated by intermission of the cardiac pulsations as well as those of the radial artery. ('Ed. Monthly Journal,' Aug. 1864, p. 172.)

Poisoning by tobacco has not often given rise to medico-legal discussion. This is the more remarkable, as it is an easily accessible substance, and the possession of it would not, as in the case of other poisons, excite surprise or suspicion. In June 1854, a man was charged with the death of an infant æt. 10 weeks by poisoning it with tobacco. He placed a quantity of tobacco in the mouth of the infant with the view, as he stated, of making it sleep. The infant was completely narcotized, and died on the second day. It is probably more extensively used to aid the purposes of robbers than is commonly believed; and there is reason to suppose that porter and other liquors sold in brothels are sometimes drugged either with tobacco or with snuff prepared from it. Scotch snuff is said to be used for this purpose. Tobacco and snuff owe their poisonous properties to the presence of a liquid volatile alkaloid, *Nicotina*.

NICOTINA.—This is a deadly poison, and like prussic acid it destroys life in small doses with great rapidity. I found that a rabbit was killed by a single drop in three minutes and a half. In fifteen seconds the animal lost all power of standing, was violently convulsed in its fore and hind legs, and its back was arched convulsively (opisthotonos). A frothy alkaline mucus escaped from its mouth, having the odour of nicotina. ('Guy's Hospital Reports,' Oct. 1858, p. 355.) A case of poisoning by this alkaloid which occurred in Belgium in 1851, was the subject of a trial for murder. ('Ann. d'Hyg.' 1851, 2, pp. 167 and 147). The *Count* and *Countess Bocarmé* were charged with the murder of the Countess's brother, a *M. Fougnies*, by administering to him nicotina while he was dining with them at the Château of Bitremont. The poison was forcibly administered. The deceased did not survive more than five minutes, and was not seen living by any of the attendants. The possession of the poison, as well as the moral evidence, fixed the crime on the Count, and he was condemned and executed. The appearances after death were to a great extent altered or destroyed by the pouring of some strong acid (acetic) into the mouth and over the body of the deceased, in order to conceal or remove the odour of nicotina. M. Stas detected the poison in small quantity in the tongue, throat, stomach, liver, and lungs of the deceased, as well as in a wooden plank of the floor near to which he was sitting. A second case of poisoning by this alkaloid, and the only case recorded in this country, occurred in London as an act of suicide in June 1858. A gentleman swallowed a quantity of nicotina from a bottle, and almost immediately after-

wards was seen in the act of falling to the floor. He was carried to an adjoining room, but before this could be reached he was dead. The symptoms noticed were that deceased stared wildly: there were no convulsions, and he died quietly, heaving a deep sigh in expiring. In producing these effects nicotina resembles prussic acid. The quantity of nicotina taken could not be determined. The deceased appears to have been rendered immediately insensible, and to have died in from three to five minutes after having taken the poison. The *appearances* observed were a general relaxation of the muscles, prominent and staring eyes, bloated features, great fulness with lividity about the neck. There was no odour resembling nicotina or tobacco perceptible about the body. When examined between two and three days after death, putrefaction had occurred, especially in the course of the veins. The swelling of the neck was found to arise from an effusion of dark liquid blood. The scalp and the membranes of the brain were filled with dark-coloured blood. The lungs were engorged and of a dark purple colour. The cavities of the heart were empty, with the exception of the left auricle, which contained two drachms of dark-coloured blood. The stomach contained a chocolate-coloured fluid (reserved for analysis): the mucous membrane was of a dark crimson red colour from the most intense congestion. There was no odour excepting that of putrefaction. The liver was congested and of a purple black colour. The blood throughout the body was black and liquid, but in some parts it had the consistency of treacle. I found nicotina in small quantity in the contents of the stomach, also in the liver and lungs; but as these organs had been placed in contact with the stomach, it could not be inferred that the poison had been absorbed and deposited in them.

Analysis.—A sample of nicotina which I examined had a pale amber colour, and evolved a peculiar acrid odour, affecting the nose and eyes, resembling when diluted that of stale tobacco-smoke. It had the consistency of a thin oil, gave a greasy stain to paper which soon disappeared, owing to its volatility. When heated on platinum or on paper it burnt with a bright yellow flame, emitting a thick black smoke. It was powerfully alkaline, and imparted a strong alkaline reaction to water without readily dissolving in it. The aqueous solution, even when much diluted, retained the peculiar odour. Nicotina is dissolved by alcohol and ether, and the latter liquid will remove it from its aqueous solution. 1. Chloride of platinum produces in the aqueous solution an orange yellow crystalline precipitate. 2. Corrosive sublimate gives a white precipitate. 3. Arsenio-nitrate of silver gives a yellow precipitate. In all these characters nicotina resembles ammonia: the differences, apart from the odour, which is an important distinction, are, 4. Iodine water gives a brown precipitate (in ammonia there is no precipitate, the colour is discharged). 5. Tannic acid gives a whitish-yellow precipitate (in ammonia there is no precipitate, but a red colour is imparted). 6. Chloride of potassium and mercury copiously precipitate it, even when much diluted. 7. Gallic acid gives no precipitate (in ammonia it produces a pinkish-red colour, rapidly changing to an olive green). 8. Sulphuric acid and bichromate of potash produce with it a green colour by the liberation of oxide of chromium. (See 'Guy's Hospital Reports,' Oct. 1858, p. 354.)

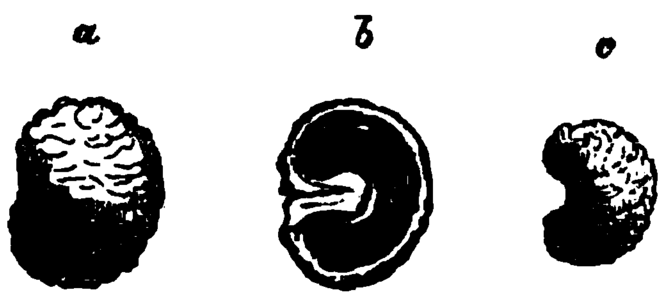
Organic mixtures.—To separate nicotina from the contents of the stomach, these should be digested in cold distilled water, acidulated with sulphuric acid in the proportion of a drop to an ounce. This liquid is strained, filtered, and the residue pressed. It is then to be evaporated to one-half in a water-bath—digested with its bulk of cold alcohol, filtered, and the alcoholic liquid evaporated in a water-bath. The sulphate of nicotina is now dissolved out of the residue by a small quantity of water, and the solution is rendered alkaline by potash and then shaken in a tube with its bulk of ether; the ethereal liquid is

allowed to evaporate in a series of watch-glasses, and if nicotina be present the alkaloid will be left in small oily-looking globules. The odour may not be perceptible until the residue is heated, when its peculiar acridity will be brought out. A few drops of water should be added to the residue in each glass—it will be found to be strongly alkaline, and the different tests may then be applied. It was by this process that I discovered the poison in the body of the gentleman whose case is above related. In reference to the rabbit killed by a single drop (*supra*), nicotina was found in the stomach and its contents: there was a trace found in half an ounce of the blood of the animal, and the poison was clearly detected after a week in the tongue and soft parts of the throat of the animal, but there was no trace of nicotina in the liver, heart, or lungs.

LEVANT NUT (COCCULUS INDICUS).

Symptoms and Effects.—This is the fruit or berry of the ANAMIRTA COCCULUS (*Levant Nut*), imported from the East Indies. The berry contains from one to two per cent. of a poisonous principle (*Picrotoxine*). The shell or husk contains no picrotoxine, but a non-poisonous principle called menispermine. The seeds, in powder or decoction, give rise to nausea, vomiting, and griping pains, followed by stupor and intoxication. There are, so far as I am aware, only two well-authenticated instances of this substance having proved fatal to man. Several men suffered from this poison in 1829, near Liverpool: each had a glass of rum strongly impregnated with cocculus indicus. One died that evening; the rest recovered. ('Traill's Outlines,' 146.) Of the second case, the following details have been published. A boy, æt. 12, was persuaded by his companions to swallow two scruples of the composition, used for poisoning fish. It contained cocculus indicus. In a few minutes he perceived an unpleasant taste, with burning pain in the gullet and stomach, not relieved by frequent vomiting—as well as pain extending over the whole of the abdomen. In spite of treatment, a violent attack of gastro-enteritis supervened, and there was much febrile excitement, followed by delirium and purging, under which the patient sank on the nineteenth day after taking the poison. On inspection, the vessels of the pia mater were congested with dark-coloured liquid blood. There was serous effusion in the ventricles of the brain, and the right lung was congested. In the abdomen there were all the marks of peritonitis in an advanced stage. The stomach was discoloured, and its coats were thinner and softer than natural. (Canstatt, 'Jahresbericht,' 1844, 5, 298.)

Fig. 51.



a. Berry of Cocculus Indicus, natural size.
b. The same, seen in section with one-half of the semi-lunar kernel.
c. The kernel, containing picrotoxine.

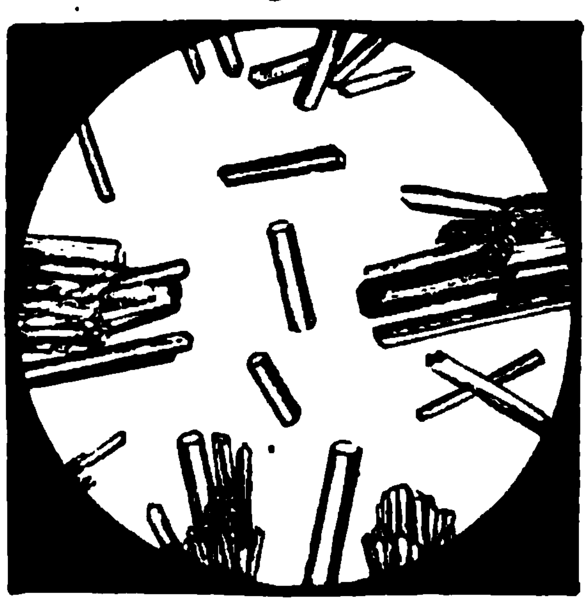
Porter, ale, and beer owe their intoxicating properties in some instances to a decoction or extract of these berries. The fraud is perpetrated by a low class of publicans. They reduce the strength of the beer by water and salt, and then give to it an intoxicating property by means of this poisonous extract. A medical man consulted me some years since, in reference to the similarity of cerebral symptoms suffered by several of his patients in a district in London. It was ascertained that they were supplied with porter by retail from the same house. The effects produced by this drug are remarkable: there is a strong disposition to sleep, and at the same time wakefulness. There is a heavy lethargic stupor, with a consciousness of passing events, but a complete loss of voluntary power. It is a kind of nightmare feeling, altogether different from healthy sleep. Cocculus indicus is sometimes used by robbers to intoxicate their victims, and to this form of intoxication the term 'hocussing'

is applied. One method of detecting this poison in alcoholic liquids consists in distilling over the alcohol and then testing the extract by physiological or chemical processes. The extract containing cocculus indicus is intensely bitter, and soon produces on man or an animal stupefying and narcotic symptoms. The extract of a genuine alcoholic liquid loses its narcotic properties when all the alcohol has been separated from it by distillation. For some remarks on this adulteration of beer and other liquids, and a process for separating the poisonous principle, picrotoxine, by amylic alcohol, see 'Chemical News,' March 12, 1864, p. 123.

Cocculus indicus operates readily as a poison on animals, and it has thus been frequently used for the malicious destruction of fish and game. In one instance referred to me, there was reason to believe that 270 young pheasants had been poisoned by grain soaked in a decoction of this substance. *Barber's poisoned wheat* for the destruction of birds owes its poisonous properties to cocculus indicus. (Horsley.)

PICROTOXINE.—The poisonous principle of the berry of cocculus indicus crystallises in slender hexahedral prisms, having a silky lustre. It is soluble in 150 parts of cold water, but is more soluble in boiling water, and the solution has a very bitter taste. When heated in a tube, picrotoxine evolves an acid vapour like digitaline. Hydrochloric acid dissolves it without change of colour. It is soluble in alcohol, ether, chloroform, and in amylic alcohol. Sulphuric acid imparts to it an orange-yellow colour, which becomes of a pale yellow by dilution. When bichromate of potash is added to the sulphuric acid mixture, green oxide of chromium is produced. Strong nitric acid dissolves it without any change of colour. Tannic acid and the chloriodide of potassium and mercury do not precipitate it from its solutions. When boiled with a solution of potash and the sulphate of copper, it reduces the oxide like grape-sugar. It is said, like salicine, to belong to the class of glucosides.

Fig. 52.



Crystals of Picrotoxine, magnified 124 diameters.

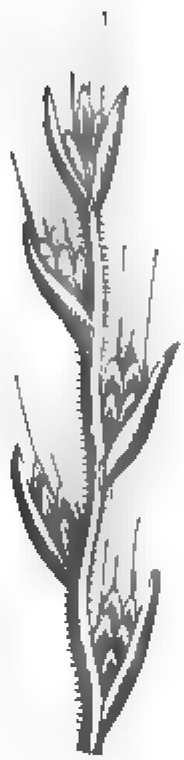
Mr. Langley has shown that this principle may be separated from many of the poisonous alkaloids by taking advantage of its peculiar chemical properties. It does not combine with acids to form salts, but readily with bases. Thus water containing a small quantity of potash will dissolve one-sixth or one-eighth part of its weight of picrotoxine. Water thus alkalised will, it is well known, readily yield most of the alkaloids to ether, when this liquid is shaken with the solution; but if the liquid is strongly acidulated, the alkaloids remain combined with the acid, while the ether shaken with the liquid entirely removes the picrotoxine. Thus, in examining beer supposed to be adulterated with cocculus indicus, the liquid should be acidulated with hydrochloric acid, and then shaken with two volumes of ether. The ethereal solution thus obtained, when spontaneously evaporated, leaves the picrotoxine in crystals. Mr. Langley states that by this process he has detected so small a quantity as 1-750th of a grain of picrotoxine in a pint of ale. The stomach of a cat which had been poisoned was treated with alcohol, and the solution evaporated to dryness. Acidulated water was poured on the residue, and the picrotoxine with some organic matter was dissolved. The acid liquid was shaken with ether, and crystals of picrotoxine were obtained by the evaporation of the ethereal solution. (See 'Pharm. Journal,' December 1862, p. 277.)

BEARDED DARNEL (LOLIUM TEMULENTUM).

Symptoms and Effects.—Poisoning by darnel is generally the result of accident from the intermixture of the seeds of this grass with wheat or rye. The seeds are ground into flour and eaten with the bread.

In January 1854, Dr. Kingsley, of Roscrea, furnished me with the particulars of some cases in which several families (including about thirty persons) suffered severely from the effects of bread containing, by accidental admixture, the flour of darnel seeds. The persons who partook of this bread staggered about as if intoxicated: there was giddiness, with violent tremblings of the arms and legs, similar to those observed in delirium tremens, but of much greater intensity (the patients requesting those about them to hold them, and experiencing great comfort from this assistance being given to them); greatly impaired vision, every object appearing of a green colour to the sufferer; coldness of the skin, particularly of the hands and feet; great prostration of strength, and in several cases vomiting. Under the free use of stimulants and castor-oil the whole of the patients were convalescent on the following day, but much debilitated from the effects of the poison. Among the symptoms in other cases there has been noticed a sense of burning heat in the mouth and throat, with confusion in the head, trembling, and a small irregular pulse. (See 'Ed. Monthly Jour.' Aug. 1850, p. 180.)

Fig. 53.



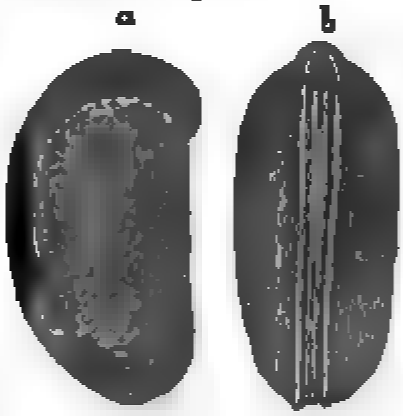
Lolium Temulentum, or Bearded Darnel.

Analysis.—The plant is known by its botanical characters. Pfaff has lately examined darnel, in order to discover a poisonous alkaloid; but there was no trace of such a substance. By distillation with water he obtained two kinds of ethereal oil, one lighter and the other heavier than water; they were colourless and had the odour of fusel-oil.

ORDEAL OR CALABAR BEAN (PHYSOSTIGMA VENENOSUM).

The Calabar bean is a large leguminous seed of a dark colour, resembling a garden bean, but much thicker and more rounded in its form. It is brought from the western coast of Africa, and is there employed by the natives as an ordeal bean when persons are suspected of witchcraft. The common belief is, that the innocent vomit and are safe, while the guilty retain the poison and die from its effects. So strong is popular confidence in this test, that those who are suspected voluntarily take an emulsion of this dreadful seed, and, as Sir R. Christison remarks, many an innocent person thus pays the penalty of his rash reliance on this superstitious custom. As it is a firm matter of faith that if a man dies he is guilty, such a custom is beyond the reach of any appeal to reason. Illustrations of this bean of its natural size are subjoined.

Fig. 54.



a. The bean of its natural size.
b. The same seen edgewise.

This bean owes its properties to the presence of an alkaloidal substance called *Physostigmia*. It is found in the cotyledon, and the process adopted for its separation by Jobst and Hesse is described in the 'Chemical News' for March 5, 1864, p. 109.

The seed or bean has a thin hard dark-coloured brittle covering; the kernel inside is white and weighs from thirty-six to fifty grains; the whole seed about sixty-seven grains. Sir R. Christison could detect no poisonous alkaloid in the seed, but he found that the active principle (physostigmia) could be extracted by alcohol, which dissolves 2·7 per cent. of the seed, including this substance. That

alcohol will remove the poisonous principle is proved by the fact that the exhausted residue is not always poisonous. (Bouchardat, 'Ann. de Thérapeutique,' 1864, p. 73. See also 'Pharm. Jour.' 1863, p. 561.) The greater part of the seed, as in nux vomica, consists of starchy and other inert matters, with a small quantity of oil. The kernel is yellowish-white, without bitterness, acrimony, aroma, or any other impression on the organ of taste. In fact it cannot be distinguished by taste from a haricot-bean.

Twenty-one grains in fine powder were placed in the cellular tissue of a rabbit; for three minutes there was no change. The animal then became weak and languid; in four minutes it was unable to raise itself when placed on its side. The body then became quite flaccid, and respiration ceased in five minutes. There were at intervals slight irregular twitchings in the muscles of the trunk, and a jerking of the head backwards. Two grains of the alcoholic extract produced similar symptoms. At the end of two minutes, without any previous indication, the animal suddenly became weak, fell on its side, struggled a little with its feet, and ceased to breathe in another minute. The poison, according to Sir R. Christison, produces a primary impression on the heart, causing paralysis of that organ, the insensibility and coma being only apparent. The results appear to show that there is also paralysis of the voluntary and respiratory muscles, but a retention of consciousness. ('Pharmaceutical Journal,' 1855, p. 473.)

Desiring to try the effects of this seed on himself, Sir R. Christison took the eighth part of a seed, or six grains, one night before going to bed. There was a slight sense of numbness in the limbs during the night, but in the morning no urgent symptoms of any kind. He then chewed and swallowed the fourth part of a seed (twelve grains). In twenty minutes he was seized with giddiness, and a general feeling of torpor over the whole frame. He immediately swallowed an emetic, and thus emptied his stomach. The giddiness, weakness, and faintness increased to such a degree that he was obliged to lie down in bed. In this state he was seen by two medical friends, who found him prostrate and pale, the heart and pulse extremely feeble and tumultuously irregular, the mental faculties entire, extreme faintness threatening dissolution, but no apprehension of death on the part of the patient. There was no uneasy feeling of any kind, no pains or numbness, no prickling, not even any sense of suffering from the great feebleness of the heart's action. There was the will but not the power to vomit; the limbs became chill with a vague feeling of discomfort. Stimulants were employed, and warmth and pulsation, with a power of moving, gradually returned. Two hours after the poison had been taken he felt drowsy, and slept for two hours more, but with such activity of mind that he had no consciousness of having been asleep. The tumultuous action of the heart continued. After this the symptoms gradually disappeared, and the next day he was quite well. ('Pharm. Jour.' 1855, p. 474.)

In August 1864, fifty children were poisoned at Liverpool by reason of their having eaten these beans. The sweepings of a ship from the west coast of Africa had been thrown on a heap of rubbish; the children found the beans and ate them. A boy, æt. 6, who ate six beans, died in a very short time. The principal symptoms were severe griping pains, constant vomiting, and contracted pupils. In addition to these symptoms the face was pale, and the eyes were bright and protruding. In attempting to walk the children staggered about as if they were drunk. In April 1864, two children, aged 6 and 3 years respectively, chewed and ate the broken fragments of the kernel of one nut. In about forty minutes they complained of sickness. One child held his head drooping, appeared sleepy, and his hands were powerless. He staggered and was scarcely able to walk. He complained of severe pain in the stomach, and made ineffectual attempts to vomit. Milk was given, and he then vomited.

The child became quite prostrated, the pulse was feeble and slow, and the pupils were slightly contracted. Some pieces of the nut were thrown up by vomiting. The other child had pain in the abdomen, and was listless, sleepy, and depressed. He vomited freely, some portions of nut being ejected. He could neither stand nor walk. His face was pale, the eyes were piercing, but the pupils and pulse were natural. In this case there was purging. The children recovered on the third day. ('Edinburgh Monthly Journal,' 1864, p. 193.) In cases in which it has proved fatal to animals it has caused much irritation and congestion of the stomach and bowels. (Dragendorff.)

A drop of the extract applied to the eye of an animal produces in from ten minutes to a quarter of an hour a remarkable contraction of the pupil. This has been observed to last in children for fifteen or twenty hours. (Bouchardat, 'Ann. de Thérapeutique,' 1864, p. 73.) In this respect, the poison is eminently distinguished from atropia, daturia, and hyoscyamia, which cause excessive dilatation of the pupil. Dr. Harley found in his experiments with this substance that it causes contraction of the pupil when taken internally, as well as when applied locally. It paralyzed the motor nerves, and left the intellect and muscular irritability unimpaired. It destroyed life by paralyzing the respiratory muscles, and although it weakened the heart's power, it neither stopped the circulation nor arrested the heart's action. It is not, according to him, a cardiac, but a respiratory poison. It is closely allied in its effects to woorara and conia, but more to the latter. It differs from both in its tendency to produce muscular twitchings, and in its power of causing contraction of the pupil. Neither woorara nor conia has any effect on the iris. ('Lancet,' 1863, 1, 717.)

Analysis.—Physostigmia combines with acids to form salts. Dragendorff found that a solution of bromine in water acted in a characteristic manner on a solution of the sulphate, even when diluted to 1-10,000th part. It produced a red colour when less than 1-1000th of a grain was present. The chloriodide of potassium and mercury also precipitates physostigmia in a much diluted state. The physiological test consists in the application of a solution or alcoholic extract to the eye. It produces strong contraction of the pupil when this liquid contains but a small fractional proportion of physostigmia. Dragendorff has found that it is absorbed and diffused throughout the body. He has separated it by means of benzole used as ether is for the preparation of strychnia. It is rapidly eliminated by the saliva and other secretions under putrefaction. (Husemann's 'Jahresbericht,' 1872, p. 570.)

Poisonous Mushrooms (Fungi).

Symptoms and Appearances.—The noxious species of mushrooms act sometimes as narcotics, and on other occasions as irritants. It would appear, from the reports of several cases, that when the narcotic symptoms are excited, they come on soon after the meal at which the mushrooms have been eaten, and that they are chiefly manifested by giddiness, dimness of sight, and debility. The person appears as if intoxicated, and there are singular illusions of sense. Spasms and convulsions have been occasionally witnessed among the symptoms when the case has proved fatal. Dr. Peddie has related three instances of poisoning by mushrooms ('Edin. M. and S. J.' vol. 49, p. 200), in which the poison acted as a pure narcotic; there was no pain in the abdomen, nor irritation in the alimentary canal. The narcotic symptoms began in half an hour with giddiness and stupor: the first effect with one patient was, that every object appeared to him to be of a blue colour. The three patients recovered, two of them rapidly. When the drowsiness passes off, there is generally nausea and vomiting; but sometimes vomiting and purging precede the stupor. If the symptoms do not occur until many hours after the meal, they partake more of

the characters of irritation; indicated by pain and swelling of the abdomen, vomiting, and purging. In a recent case of poisoning by mushrooms, there was slight vomiting about an hour and a half after the meal, but no violent symptoms until after the lapse of ten hours. Several cases, in which the symptoms did not appear until after the lapse of fourteen hours, are reported in the 'Medical Gazette' (vol. 25, p. 110). In some instances the symptoms of poisoning have not commenced until thirty hours after the meal; and in these, narcotism followed the symptoms of irritation. It might be supposed that these variable effects were due to different properties in the mushrooms; but the same fungi have acted on members of the same family, in one case like irritants, and in another like narcotics. In most cases recovery takes place, especially if there is early vomiting. In the few instances which have proved fatal, there has been greater or less inflammation of the stomach and bowels, with congestion of the vessels of the brain. (See 'Med. Gaz.' vol. 46, p. 307; vol. 47, p. 673; and 'Journ. de Chimie. Méd.' 1853, p. 694.)

Mr. Taylor, of Emsworth, relates a fatal case of poisoning by fungi which was attended with symptoms of irritation resembling those caused by arsenic. There was no loss of consciousness or sensibility. G. F., æt. 13, fried and ate for breakfast at 8.30 A.M. two fungi which he had found growing under a tree. He returned to his work without complaint. At 12 he had his dinner of pork and vegetables. At 1 P.M. he returned to work, where he remained until 6 P.M., working the whole time without any complaint. Soon after he reached home, he complained of feeling ill and vomited violently. Purging then followed with severe spasmodic pain in the abdomen. These symptoms continued throughout the night until 6 A.M. The bowels then ceased to act. Mr. Taylor saw him at 11.30 A.M. He was then suffering from constant pain in the bowels, occasionally aggravated: there was tenderness over the abdomen generally, but especially over the course of the transverse colon, with vomiting every ten minutes—great thirst, skin warm and perspiring, pulse 90, and great depression. At 3 A.M. on the second day he was again seen. Vomiting and purging had returned. There was great exhaustion; pulse imperceptible; the action of the heart feeble. He was lying in bed on his back, with the knees drawn up. Sensibility and consciousness were perfect. He complained of great pain in the stomach; there was tenderness over the abdomen, but no swelling of the cavity. In another hour he died, *i.e.* about forty-four hours after eating the fungi, and about thirty-four after the first setting-in of the symptoms. Others partook of the fungi, but in small quantity, and they did not suffer. On inspection, the heart on the right side contained a little fluid blood. The left ventricle was contracted and empty. The lungs were healthy, and there was only cadaveric congestion. The lining membrane of the stomach and small intestines was throughout injected, the bluish-red appearance diminishing in intensity as it approached the cæcum. There were a few ecchymosed patches near the intestinal end of the stomach. The organ contained six ounces of a brownish liquid resembling thin gruel. The large intestines were empty and pale, and the spleen was congested; the other organs were healthy. ('Med. Times and Gaz.' Nov. 21, 1863, p. 536). In many of its features, and in the absence of narcotic symptoms, this case resembled a case of acute poisoning by arsenic. The fact that nearly ten hours elapsed before the symptoms of irritation commenced, and that there was no blood in the matters discharged by vomiting and purging, were the most marked differences.

In August 1871, two children died at Flushing near Falmouth, from the effects produced by noxious fungi. Several other persons were placed in a precarious condition from the same cause. Some fowls died from eating portions of the mushrooms. A fatal case is reported by Dr. Stevenson ('Guy's Hosp. Rep.' 1872, p. 228). Other cases of poisoning by fungi are reported in Husemann's 'Jahresbericht' (1872, p. 534). A man, æt. 43, and his daughter,

æt. 5, suffered severely from eating the *Amanita panthernia.* The earliest symptoms appeared in two hours and a half after the meal. They were thirst, faintness, delirium, nausea, paleness of the face and cold extremities. After eleven hours, there was stupor with tenderness of the abdomen. In the child, there was cyanosis of the legs with contracted pupils. It was remarked that even fourteen hours after the fungi had been eaten, portions of them were discharged by vomiting from the action of emetics. They both recovered. It is strange that with such facts as these occasionally presenting themselves, educated persons can be found who persist in denying that mushrooms are under any circumstances poisonous! In a period of four years (1865–7) six deaths were recorded to have taken place from eating poisonous fungi.

Analysis.—The discovery of portions of the mushrooms undigested in the matter vomited, or a description of the food eaten, will commonly lead to a recognition of this form of poisoning. The poisonous principle contained in mushrooms is called *fungin*; it appears to be of a volatile nature and soluble in hot water; for some varieties of noxious mushrooms may be eaten with impunity, when they have been well boiled in water and afterwards pressed. One of the most poisonous in this country, *Amanita muscaria* or Fly-mushroom, renders the water in which it is boiled so poisonous, that animals are killed by it, while the boiled fungus itself has no effect upon them. The liquid procured from it is used as a fly-poison, whence the name of the mushroom is derived. It is an autumnal fungus, known by its rich orange-red colour.

MM. Sicard and Schoras affirm that the poisonous principle in many species of mushrooms is an alkaloid, as it unites with acids and forms salts. The salt so obtained is extremely poisonous. It was rapidly fatal to frogs, and a small quantity was sufficient to kill a dog. Its effects on animals, according to them, were similar to those produced by *curarina.* ('Dub. Med. Press,' Nov. 1865.) Some fungi which were exposed for sale in open market have been properly seized and condemned as unfit for human food. An experienced mycologist (the Rev. J. Berkeley) says, 'No general rule can be given for the determination of the question whether fungi are or are not poisonous. Colour is quite indecisive, and some of the most dangerous fungi, and amongst them the *Agaricus Phalloides,* are void of any unpleasant smell when fresh, though the most wholesome may be extremely offensive when old. Experience is the only safe test, and no one should try species incautiously with whose characters he is not thoroughly acquainted.' The learned mycologist who gives this advice appears to have forgotten that a person may lose his life in making this 'thorough acquaintance' with the characters of fungi.

HENBANE (HYOSCYAMUS NIGER).

Symptoms and Appearances.—The seeds, roots, and leaves of this plant are poisonous. When the dose is not sufficient to destroy life, the symptoms are —general excitement, fulness of the pulse, flushing of the face, weight in the head, giddiness, loss of power and tremulous motion of the limbs, somnolency, dilatation of the pupils, double vision, nausea, and vomiting. After a time these symptoms pass off, leaving the patient merely languid. When a large quantity of the *root* or *leaves* has been eaten, an accident which has occurred from the plant having been mistaken for other vegetables, more serious effects have been manifested. In addition to the above symptoms in an aggravated form, there may be loss or incoherency of speech, delirium, confusion of thought, insensibility, coma, and sometimes a state resembling insanity; the pupils are dilated and insensible to light, there is coldness of the surface, cold perspiration, loss of power in the legs, alternating with tetanic rigidity and convulsive movements of the muscles; the pulse small, frequent, and irregular, the respiration deep and laborious. (See 'Med. Gaz.' vol. 47, p. 640.) Occa-

sionally there is nausea with vomiting and purging. Death may take place in a few hours or days, according to the severity of the symptoms. The special effect of this poisonous plant is manifested in its tendency to produce a general paralysis of the nervous system.

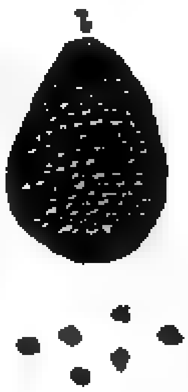
One fatal case of poisoning with the roots of henbane is quoted by Orfila, and another with the leaves is reported by Wibmer (op. cit. p. 147). The appearances consisted in a general congestion of dark-coloured liquid blood in the venous system. The lungs and brain especially manifested this condition. There are commonly no marks of irritation or inflammation in the stomach and bowels.

Analysis.—When the vegetable has been eaten, it can be identified only by its botanical characters. The seeds are very small and hard; they are furrowed on the surface, and may be easily confounded with those of belladonna. They are of an oblong, oval, or pyriform shape. We subjoin illustrations, in which they are represented magnified (*b*) and of their natural size (*a*) fig. 56. The leaves are peculiar in shape and other characters, by which they may be easily identified. The annexed illustration (fig. 55) is from a photograph of a fresh leaf of henbane. The poisonous properties of henbane are known to be owing to the presence of a crystalline alkaloidal body, which is called *Hyoscyamia*. It is very difficult of extraction. The crystals have a silky lustre,—they are not very soluble in water, but are easily dissolved by alcohol and ether. It has an alkaline reaction, and its saline solutions are precipitated by tannic acid. It has an acrid disagreeable taste, resembling that of tobacco. It is highly poisonous, and causes dilatation of the pupils.

Fig. 55.

Small leaf of Henbane of its natural size and form.

Fig. 56.



Seeds of Henbane. *a.* Natural size. *b.* Magnified 20 diameters.

Lactucarium (Lactuca).

Symptoms and Effects.—The two species of lettuce, known under the names of Lactuca sativa and virosa, contain a principle which is possessed of feebly narcotic properties. Orfila has found that the extract prepared by evaporation at a low temperature, acts upon the brain and nervous system of animals; although very large doses were required for the production of narcotic effects. There is no record of these plants having exerted a poisonous action in the human subject. The inspissated juice of the lettuce is well known under the name of *lactucarium* or *lettuce-opium*. The juice, when it first escapes, is of a milky-white hue, but, in drying, it forms an extract in small irregular dry masses of a brown colour, a bitter taste, and with an odour similar to that of opium. It has a weak narcotic action when given in doses of from five to twenty grains. It varies much in strength. Wibmer found that *two grains* caused headache and somnolency. (Op. cit. 200.) It is bitter to the taste, which appears to be owing to the presence of a bitter principle called *lactucin*, upon which its feebly narcotic properties probably depend. There are no tests for lactucarium, further than the colour, the opiate odour with the want of solubility, and the absence of the other chemical characters of opium.

Nightshade (Solanum).

Symptoms and Effects.—There are two species of this plant—the *Solanum dulcamara*, *Bitter-sweet* or *Woody-nightshade*, which has a purple flower and bears red berries; and the *Solanum nigrum*, or *Garden-nightshade*, with a white flower and black berries. The active principle *Solania*, on which the poisonous properties of both species depend, varies in proportion at different seasons of the year. In one instance a decoction of the plant is said to have produced in a man dimness of sight, giddiness, and trembling of the limbs,—symptoms which soon disappeared under slight treatment. (For a case of poisoning by the decoction, see 'Med. Gaz.' vol. 46, p. 548.)

The berries of the Solanum nigrum, in one instance at least, produced serious effects in three children who had eaten them. They complained of headache, giddiness, sickness, colic, and tenesmus. There was copious vomiting of a greenish-coloured matter, with thirst, dilated pupils, stertorous breathing, convulsions, and tetanic stiffness of the limbs. One child died in the acute stage: the others died apparently from secondary consequences during treatment. (Orfila, op. cit. 4ème ed. 2, 273.) From three to four berries of this plant have been found to produce sleep. In September 1853, the red berries of the *Woody-nightshade* are stated to have caused the death of a boy, æt. 4, under the following circumstances. He had eaten some of the berries, and at first did not appear to suffer from them; but eleven hours afterwards he was attacked with vomiting, purging, and convulsions, which continued throughout the day; the child being insensible in the intervals. He died convulsed in about twenty-fours. The vomited matters were of a dark greenish colour and of a bilious character. Other children had partaken of the berries at the same time: but among these, one only suffered slightly. ('Lancet,' June 28, 1856, p. 715.)

(Spinal Poisons.)

CHAPTER 30.

NUX VOMICA—STRYCHNIA—SYMPTOMS AND APPEARANCES—TIME OF OCCURRENCE OF SYMPTOMS—FATAL DOSE—PERIOD OF DEATH—CHEMICAL AMD MICROSCOPICAL ANALYSIS OF NUX VOMICA AND STRYCHNIA—TESTS—PROCESS FOR ORGANIC MIXTURES—DETECTION OF STRYCHNIA IN THE TISSUES—BRUCIA.

Nux Vomica. Strychnia.

Nux Vomica in powder has a bitter taste, and cannot therefore be easily administered in a poisonous dose without exciting suspicion. It owes its poisonous properties to the presence of the alkaloid *strychnia* associated with another alkaloïd named *brucia* in the proportion of about one per cent. and sometimes less. Strychnia itself has a very bitter taste even in very small quantity; but as it destroys life in a small dose, and it may be given in the form of pills or professedly administered as quinine or other medicines, it offers every facility for criminal administration.

Symptoms.—At a variable interval after taking either nux vomica or strychnia in a poisonous dose, the patient experiences a sense of uneasiness and restlessness, accompanied by a feeling of impending suffocation. There is a shuddering or a trembling of the whole frame, with twitchings and jerkings of the head and limbs. Tetanic couvulsions then commence suddenly with great violence, and nearly all the muscles of the body are simultaneously

affected. The limbs are stretched out involuntarily, the hands are clenched: the head after some convulsive jerkings is bent backwards, and the whole of the body becomes as stiff as a board. As the convulsions increase in frequency and severity, the body assumes a bow-like form (opisthotonos), being arched in the back and resting on the head and heels. The head is firmly bent backwards, and the soles of the feet are incurvated or arched and everted, the legs sometimes separated. The abdomen is hard and tense, and the chest spasmodically fixed, so that respiration appears to be arrested. The face assumes a dusky, livid, or congested appearance, with a drawn, wild, or anxious aspect; the eyeballs are prominent and staring, and the lips are livid. The intellect is clear, and the sufferings during this violent spasm of the voluntary muscles are severe. The patient in vain seeks for relief in gasping for air, and in requiring to be turned over, moved, or held. The muscles of the lower jaw, which are the first to be affected in tetanus from disease, are generally the last to be affected by this poison. The jaw is not always fixed during a paroxysm. The patient can frequently speak and swallow, and great thirst has been observed among the symptoms. In some cases of poisoning by nux vomica, the jaw has been fixed by muscular spasm; but, unlike the lock-jaw of disease, this has come on suddenly in full intensity with tetanic spasms in other muscles, and there have been intermissions which are not witnessed in the tetanus of disease. The sudden and universal convulsion affecting the voluntary muscles has sometimes been so violent that the patient has been jerked off the bed. After an interval of half a minute to one or two minutes, the convulsions subside, there is an intermission, the patient feels exhausted, and is sometimes bathed in perspiration. It has been noticed in some of these cases that the pupils during the paroxysms are dilated, while in the intermission they are contracted. The pulse during the spasms is so quick that it can scarcely be counted. Slight causes, such as an attempt to move, a sudden noise, or gently touching the patient, will frequently bring on a recurrence of the convulsions. In cases likely to prove fatal, they rapidly succeed each other, and increase in severity and duration, until at length the patient dies utterly exhausted. The tetanic symptoms produced by strychnia, when once clearly established, progress rapidly either to death or recovery. The patient is conscious, and the mind is commonly clear to the last. He has a strong apprehension of death. The duration of the case, when the symptoms have set in, is reckoned by minutes; while in the tetanus of disease, when fatal, it is reckoned by hours, days, and even weeks. As a general statement of the course of these cases of poisoning, within two hours from the commencement of the symptoms, the person either dies or recovers, according to the severity of the paroxysms and the strength of his constitution. Death sometimes takes place in a paroxysm. (See case by Mr. Lawrence, 'Lancet,' June 1861, p. 572.)

The *time at which the symptoms commence* appears from the recorded cases to be subject to great variation. In poisoning by nux vomica the symptoms are generally more slow in appearing than in poisoning by strychnia. Until they set in suddenly, the patient is capable of walking, talking, and going through his or her usual occupations. In a case which occurred to M. Pellarin, a man swallowed about 300 grains of nux vomica and no symptoms appeared for two hours. He then died rapidly in a violent convulsive fit. ('Ann. d'Hyg.' 1861, 2, 431.) On an average in poisoning by strychnia the symptoms appear in from five to twenty minutes. In one case convulsions came on in five minutes. ('Ann. d'Hyg.' 1861, 1, 133.) In two cases at least, an hour has elapsed. ('Lancet,' August 31, 1850. 'On Poisoning by Strychnia,' 1856, p. 139.) In a case which occurred to Drs. Lawrie and Cowan, in June 1853, an hour and a half elapsed. In 1848, Dr. Anderson met with an instance in

which *two hours and a half* elapsed before the appearance of symptoms. ('Poisoning by Strychnia,' p. 42.) The longest interval recorded was in the following case:—A boy, æt. 12, swallowed a pill containing three grains of strychnia. No symptoms appeared for *three hours*; they then set in, in the usual way, and death took place in ten minutes. It was clearly proved that the pill taken contained three grains of strychnia with mucilage. The pills had been prepared eight months previously for the purpose of poisoning dogs; hence they were hard, and would undergo only a slow solution in the stomach. ('Lancet,' 1861, 2, 480.)

The form in which the poison is administered or applied has a considerable influence on the time at which the symptoms commence. Thus when strychnia is given in pills, especially if, as in the above case, they are hard, the symptoms are much longer in appearing than when the poison is taken in solution. Mr. Savory gave to a dog two bread pills, each containing one quarter of a grain of strychnia. No symptoms of poisoning had occurred at the end of *two hours*, but the animal was found dead a short time afterwards. When strychnia was given in solution the symptoms soon appeared, and death took place rapidly. ('Lancet,' 1863, 1, pp. 515, 548.) It is remarkable that so simple a fact connected with the absorption of this poison should have been wholly ignored by some of the experts who appeared for the defence of William Palmer (*Reg.* v. *Palmer*, C. C. C., 1856). Palmer gave to the deceased, Cook, two pills containing strychnia. No symptoms were observed for an hour and a quarter. More than one expert swore strongly that this interval rendered it impossible that the symptoms could have been caused by strychnia! It was fortunate for the ends of justice that the jury put no confidence in strong statements thus made without any reasonable amount of experience to warrant them. The above-mentioned cases will show the great danger of trusting to such dogmatic opinions.

If the poison is applied hypodermically to the cellular membrane, to an ulcerated or diseased surface, or even a healthy mucous surface, absorption takes place rapidly, and the interval for the production of symptoms is proportionably short. Dr. Schuler relates a case of amaurosis in which about the 1-12th part of a grain of strychnia was introduced into the punctum lachrymale at the corner of the eye. Three or four minutes had not elapsed when symptoms of poisoning appeared. There was convulsive respiration, with violent tetanic shocks, and the patient appeared about to die: however, the symptoms passed off, and he recovered. ('Med. Times and Gazette,' July 1861.)

Appearances after death. Externally.—In general the body is relaxed at the time of death, and stiffens afterwards: but the commencement and duration of the rigid state depend on various conditions. In the case of Mrs. Vyse's two children (*Reg.* v. *Vyse* C. C. C., 1862), who died in less than an hour from the effects of Battle's Vermin Killer, administered by the mother, Mr. Savory made the following observation:—He saw the bodies soon after death. They were much discoloured, livid, and although quite warm, were perfectly rigid. The younger, aged five years, was rigid all over: the elder principally about the jaws and neighbouring parts. The rigidity gradually disappeared, and after twenty-four hours there was scarcely any remaining in the elder child. Decomposition had commenced, the front of the abdomen presenting a green discoloration. The body of a person poisoned by strychnia may therefore be found in a non-rigid state within the ordinary period after death; but in most recent cases it is not unusual to find the hands clenched and the feet arched or turned inwards,—incurvated. In the case of *Cook*, the rigidity of the limbs, including the hands and feet, is reported to have been well-marked when the body was disinterred about two months after burial.

In other instances of undoubted strychnia-poisoning no particular degree of

rigidity has been found at any period after death. In rabbits poisoned by similar doses of strychnia, I have observed the body of one to remain perfectly rigid for a week, while another had lost all rigidity and had begun to putrefy after thirty-six hours. The circumstances which affect the commencement and duration of this condition of the dead body have been elsewhere described (see p. 58). The experiments of Brown-Séquard have conclusively shown that it is not any special influence of the poison on the muscles, but the mode in which it operates on the system, that determines the commencement and duration of rigidity in the dead body.

In an accurately observed case recorded by the late Professor Casper of Berlin, the body was examined forty-one hours after death. It presented the slight greenish tinge of incipient putrefaction in the loins: there was slight humidity; the expression of the face was that of one quietly sleeping—the eyes were closed, the pupils neither contracted nor dilated. Rigidity was present in its usual degree for the time of observation—well-marked as it always is in the masseter muscles by which the jaws were firmly closed, and more strongly marked in the limbs which were lying parallel with the trunk. The feet were not incurvated: the fingers as in other dead bodies were half flexed inwards, and the nails were blue. There was no evidence of tetanic, still less of opisthotonic stiffness or rigidity of the body. In short, this body was externally precisely like a thousand other bodies ('äusserlich genau wie tausend andre Leichen') which had come before him; and any physician not informed of the mode of death, would have had no suspicion whatever of death by strychnia from the external appearances. (See report of this remarkable case revised by Casper within a few hours of his own death, in Horn's 'Vierteljahrsschrift für gerichtliche Medicin,' Juli 1864, p. 7.) A man who clears away an error in medical jurisprudence, does as much service to science as he who discovers a new truth.

Among the *internal* appearances which have been met with in different cases, is congestion of the membranes and substance of the brain, as also of the upper part of the spinal marrow, with congestion of the lungs. The heart is contracted and empty; but its right cavities in some instances have been distended with liquid blood. The blood has been found black and liquid throughout the body. The mucous membrane of the stomach has occasionally presented slight patches of ecchymosed congestion, probably depending on extraneous causes; such as the process of digestion, the presence of food or alcoholic liquids. In most instances the stomach and intestines have been found quite healthy, and it is not in the nature of this poison either to inflame or irritate the mucous membrane. Of the appearances observed in poisoning by strychnia, there are none which can be considered strictly characteristic. Congestion of the membranes of the brain and spinal marrow is probably the most common. In a case which occurred to Mr. Startin, a man who had taken strychnia medicinally, died in less than three hours from a dose of a grain and a half. On inspection, there were extensive patches of extravasated blood beneath the arachnoid membrane of the lower half of the spinal cord. ('Med. Times and Gazette,' March 21, 1857, p. 297.) With regard to the state of the heart and lungs, their condition as to fulness or emptiness must depend rather on the mode of dying, than on the actual cause producing death.

The late Professor Casper of Berlin, who had the largest medico-legal practice in Germany, states that out of nearly 1,200 medico-legal inspections made by him up to December 10, 1863, no case of death from strychnia had come before him. At that date he made a careful examination of the body of a man, who had destroyed himself with strychnia, with a view, if possible, of fixing the special appearances produced by this poison, and of isolating them from those casual conditions of the dead body which have been wrongly described as cha-

racteristic of the effects of strychnia. On December 10, 1863, a healthy man, æt. 30, swallowed, at 5 o'clock P.M., from five to six grains of strychnia. For about an hour, he lay in his room quietly. At this time spasms commenced, and in his attempt to reach a window he fell and lost all power of moving his legs. He was not seen for another hour, when he was found on the floor, asking for water. In attempting to raise himself, he was seized with tetanic convulsions affecting the whole of his muscles: he had three of these fits in a severe form, and died in the last at 8.15 P.M. During the spasms, as well as in the intervals, there was complete consciousness.

The external appearances in this case have been already described (p. 406). The two outer membranes of the brain were filled with blood: which throughout the body was generally fluid as in death from asphyxia—it was of a light reddish colour, as in poisoning by carbonic oxide or prussic acid. The brain and spinal marrow were healthy. The muscles of the throat and gullet were of a dark violet colour, unlike the other muscles of the body. The lungs were natural—not congested. The right cavities of the heart were collapsed and empty, and the left cavities contained but little blood. The large vessels were also nearly empty. The spleen was congested. The stomach was half full of a mass of partly digested food: the mucous membrane was pale, firm, and softened, and when minutely examined by a lens, was found to be perfectly natural. The mucous membrane of the whole of the intestinal canal was in the same healthy state. The kidneys were healthy and not congested. The spinal marrow was especially examined throughout its whole extent, as well as the roots of the spinal nerves. It was cut into in various directions: and in no part did it present any appearance deviating from the healthy condition. So far as appearances went, there was no visible cause of death in the case of an adult, healthy man, dying in less than four hours from a large dose of this powerful poison, and obviously from its immediate effects. In this respect, strychnia resembles other alkaloidal poisons (Horn's 'Vierteljahrsschrift,' Juli 1864, p. 28.)

Casper considers the peculiar colour of the muscles of the throat and gullet, as worthy of notice. This was the only deviation from the ordinary appearances which he had been accustomed to meet with in cases of violent death. If he had had no previous experience of the condition of the body in death from strychnia, he had had, during a long and active life, unsurpassed opportunities of observing the appearances in all other kinds of violent death. He was thus in a better condition than others to fix upon any that were really characteristic of poisoning by strychnia. Although the examination of a dead body is thus proved to throw but little light upon the question of death from strychnia, still a medical jurist has in the symptoms, their mode of occurrence and progress, sufficient data for a safe opinion.

Quantity required to destroy life.—The medicinal dose of strychnia for an adult ranges from 1-30th to 1-12th of a grain. The 1-16th of a grain is an average dose. This quantity has operated as a poison on a child. It caused the death of a child between two and three years of age in four hours. In a case reported by Dr. Danvin, three-quarters of a grain killed a child, æt. 7½, in half an hour. ('Annales d'Hygiène,' 1861, 1, 133.) In two cases of adults, in each of which a quarter of a grain had been taken by mistake, the patients recovered only under early treatment. ('Lancet,' July 26, 1856, pp. 107, 117.) The smallest fatal dose in an adult was in the case of *Dr. Warner*. *Half a grain* of the sulphate of strychnia here destroyed life. ('On Poisoning by Strychnia,' pp. 138, 139.) So powerful are the effects of this drug in certain cases, that ordinary medicinal doses can scarcely be borne. A gentleman took 1-20th of a grain of strychnia in six doses during a period of two or three days. Severe fits of tetanus occurred, although half a grain had not been taken

altogether. It is probable in such cases that elimination is either arrested or imperfectly performed. In May 1859, Dr. Tweedie informed me of a case in which he had prescribed for a gentleman, pills, each containing 1-15th of a grain of strychnia. He took altogether five of them, or ⅓rd of a grain, at proper intervals. The patient was seized with the most alarming tetanic convulsions, continuing for some time. There was also opisthotonos of a severe kind. He only slowly recovered. A *fatal dose* of strychnia for an adult may be assigned at from half a grain to two grains.

As in other cases of poisoning, many recoveries have taken place, even after large doses of strychnia have been taken. There are at least three instances on record in which persons have recovered after taking one grain. A case of recovery from two to three grains is reported in the 'Lancet' for 1861, 2, 169.) In the same journal for 1863, 1, 54, Dr. Angell describes a case in which a girl recovered in six or seven hours from a dose of *four grains* of strychnia. When first seen, she was sensible, and while talking was suddenly seized with the usual tetanic symptoms—opisthotonos, concave contraction of the hands and feet, the muscles rigid, the eyes natural, the pulsations of the heart considerably increased, the respiration difficult, and great fear of death. She had only three paroxysms, and to this probably her recovery was due, as her system was not exhausted by severe and frequent convulsive attacks. There is one instance reported in which a person is said to have recovered from a dose of seven grains of strychnia ('Med. Gaz.' vol. 41, p. 305). In reference to this alleged recovery from large doses, it may be a question whether the strychnia was not mixed with some other substance, whereby its poisonous properties were weakened. Instances of recovery from doses of above one or two grains must be regarded as exceptional.

With respect to *nux vomica*, three grains of the alcoholic extract have destroyed life. The smallest fatal dose of the powder was in a case reported by Hoffmann, and quoted by Christison (p. 901), also by Trail ('Outlines,' p. 137). *Thirty grains* of the powder, given in two doses of fifteen grains each, proved fatal. The poison was given by mistake for bark to a patient labouring under quartan fever. This is about equivalent to the weight of one full-sized seed, and to only one-third of a grain of strychnia in two doses. The dose of nux vomica required to destroy life became of some importance in *Reg.* v. *Wren* (Winchester Spring Assizes, 1851). The prisoner was convicted of an attempt to administer this poison in milk; the quantity separated from the milk amounted to forty-seven grains, which was above a fatal dose. The intense bitterness which the nux vomica gave to the milk led to detection, and this would, in general, be a bar to the criminal administration of this poison, except in the form of extract in pills.

Period at which death takes place.—In fatal cases death generally takes place within two hours after the taking of the strychnia. In the case of *Dr. Warner* the symptoms commenced in five minutes, and he was dead in twenty minutes. On the other hand, in the case of *J. P. Cook*, the symptoms did not commence until fifty-five minutes after the poison was taken, but the case terminated fatally in twenty minutes after their commencement. In 1870 two deaths are reported to have occurred at Ypres in Belgium, in which strychnia proved more rapidly fatal than in the cases of Warner and Cook. *M. Merghelynk* took in pills seven grains and a half of what he supposed to be hydrochlorate of quinine. Violent convulsions came on, and he died in a quarter of an hour. His wife, not suspecting anything wrong, took a similar dose and died in *ten minutes*. A pill containing a grain and a half was given to a dog, which died under the usual symptoms of poisoning by strychnia. The supposed hydrochlorate of quinine was then examined, and it was found to be largely mixed with strychnia. The case of *Madame Merghelynk* is, with one exception, the most rapid

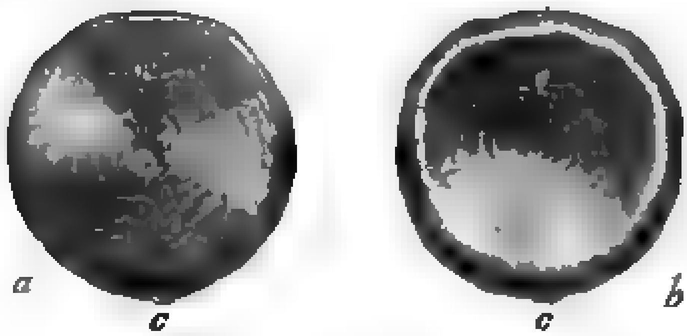
on record. Dr. J. Gray refers to a case which proved fatal in five minutes. ('STRYCHNIA,' 1872, p. 55.) One of the longest cases for duration was communicated to me by Mr. Wilkins. The deceased, an adult, died in *six hours* from a dose of three grains of strychnia. ('Guy's Hosp. Reports,' Oct 1857, p. 483.) In poisoning by *nux vomica*, death usually occurs within two hours; but Sir R. Christison mentions a case in which a man died in *fifteen minutes* after taking a dose (op. cit. p. 898.) This is probably the shortest period known. There are several instances of recovery on record, even after large doses. Mr. Iliff has reported a case in which a female recovered after taking two drachms of nux vomica. ('Lancet,' Dec. 15, 1849.)

Vermin and Insect Killers.—Although it is difficult to procure strychnia at a druggist's shop, it is extensively sold to the public by grocers, oilmen, and others, under the name of Vermin Killers, in threepenny and sixpenny packets. *Butler's Vermin Killer* consists of a mixture of flour, soot, and strychnia. I have found the sixpenny packet to weigh about a drachm, and to contain from two to three grains of strychnia. As the poison is mechanically mixed with the other ingredients, and is probably manufactured on a large scale, the proportion of strychnia is liable to variation. By the aid of a lens, the poison may be sometimes seen scattered in white particles through the coloured powder. The threepenny packet contains about half the quantity of strychnia, but, as it will be seen, quite sufficient to destroy the life of an adult. In place of soot, Prussian blue is sometimes used as a colouring substance. *Battle's Vermin Killer* is a powder similar to that of Butler, containing a fatal proportion of strychnia, as it is sold in packets. These powders are a fertile source of poisoning either through accident or design: they are openly sold by ignorant people to others still more ignorant. In *Reg.* v. *Vamplew* (Lincoln Autumn Assizes, 1862), it was proved that the prisoner, a girl under 13 years of age (!), had purchased one of these powders at a village shop and had destroyed her master's infant with it. There was also reason to believe that this girl had destroyed two infants by similar poisons in two other families where she had acted as nurse. They had all died suddenly in fits! In the above case, I examined a similar powder purchased for threepence at the same shop, and found it to consist of about thirteen grains of flour, coloured with Prussian blue and mixed with three-quarters of a grain of strychnia. Another Battle's powder, purchased in London for threepence, weighed like this about thirteen grains, and a sixpenny packet weighed twenty-three grains. The poison is therefore in a more concentrated form than in Butler's powder. A case in which a young woman was killed in two hours by a threepenny packet of this powder was communicated to me in July 1864: and another in which a drachm-packet of Butler's killer destroyed a girl, æt. 17, in one hour, has been reported by Mr. Saville ('Med. Times and Gaz.' Nov. 1857). It would be easy to add to these many other fatal cases which have fallen within my own knowledge; but they present nothing out of the usual course. The persons have all died under the ordinary symptoms of poisoning by strychnia, in a well-marked form. The appearances in the body were similar to those seen in death from strychnia: but there is one caution to be given in reference to the examination of the stomach. As death is commonly rapid and there is no vomiting, the colouring matter, either soot or Prussian blue, should always be sought for in the stomach. Strychnia may or may not be found, according to the amount swallowed and the degree to which absorption has gone on during life. Some cases of recovery are reported. In 1859 a man recovered after taking a whole packet containing nearly three grains of strychnia ('Ed. Monthly Journal,' 1859, vol. 2, p. 507); and in 1860 Dr. Part met with an instance of recovery in which a girl took half a packet. In these cases the favourable results were probably due to vomiting excited by emetics. In 1863–7, over a period of four years,

the deaths from strychnia in England and Wales were forty-one, and from vermin-killers twenty.

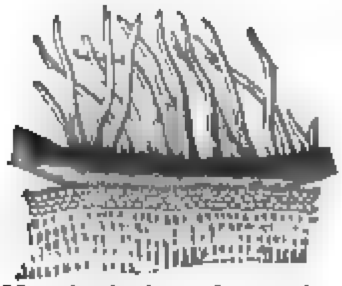
Chemical Analysis.—Nux vomica is well known as a flat round kernel, about the size of a shilling, with radiating silken fibres, slightly raised in the centre (figs. 57 and 58). It is of a light brown colour, and covered with a fine silky down. It is very hard, brittle, tough, and difficult to pulverize. The powder is of a grey brown colour, like that of liquorice: it is sometimes met with in a coarsely rasped state; it has an intensely bitter taste. It yields to water and alcohol, strychnia, brucia, igasuric or strychnic acid, and some common vegetable principles. Heated on platinum-foil, it burns with a yellow smoky flame. Nitric acid turns it of a dark orange-red colour, which is destroyed by chloride of tin. These properties are sufficient to distinguish it from various medicinal powders which it resembles. In one case of poisoning by this substance (*Reg.* v. *Wren*) I found a quantity of guaiacum powder mixed with the nux vomica. This so completely changed the action of nitric acid, as in the first instance to create some difficulty in identifying the substance. The analyst must be prepared for these admixtures or adulterations.

Fig. 57. Fig. 58.



Seeds of Nux Vomica, natural size. *a.* convex surface; *b.* concave surface; *c.* hilum or umbilicus.

Fig. 59.



Magnified view of a section of Nux Vomica, showing the hairs projecting from the surface (Pereira).

Fig. 60.

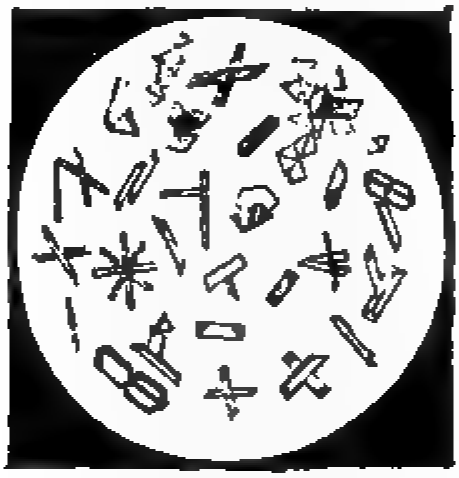
Hairs of Nux Vomica, magnified 124 diameters.

The aqueous *infusion* or *decoction* is reddened by nitric acid, and is freely precipitated by tincture of galls. Persulphate of iron gives with it an olive-green tint. The fine silky fibres or hairs which cover the surface of the seed may be obtained by washing the residue of the powder in the stomach, or the sediment of any liquid with which the nux vomica may have been mixed. They present a characteristic appearance under the microscope (fig. 60). As in other poisonous seeds or roots, the strychnia is slowly removed from the powder by the absorbent vessels of the stomach, and carried into the blood, until that liquid is sufficiently impregnated with the poison to produce symptoms. The powder itself remains, as it is unalterable by the fluids of the stomach. Strychnia may be extracted from nux vomica by a simple process, which is described at p. 413.

Strychnia.—This alkaloid may be readily obtained crystallized from an alcoholic solution. The crystal is very small, and its form is subject to great variation, according to the strength of the solution, rapidity or slowness of evaporation, the presence of foreign matters, &c. It is commonly seen in octahedra, sometimes lengthened into prisms of a peculiar shape, bevelled at

the ends, and crossing each other at angles of 60°. (See fig. 61.) There are as many as six or eight varieties of crystals, so that too much importance must

Fig. 61.



Various forms of Crystals of Strychnia, as they were obtained from an alcoholic solution, magnified 124 diameters.

Fig. 62.

Crystals of Strychnia, obtained by adding ammonia to the sulphate, magnified 124 diameters.

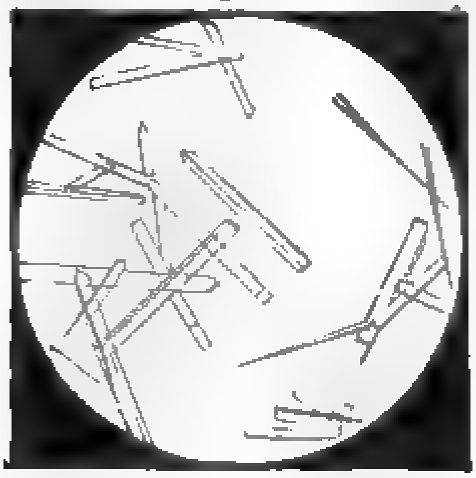
not be attached to this branch of the analysis. As strychnia is procured from the solutions of its salts by the addition of ammonia, it is usually deposited in long slender prisms. (Fig. 62.)

1. Strychnia is white, of an intensely bitter taste, even when it forms only 1-30,000th part of a solution. 2. When strongly heated on platinum, it melts and burns like a resin, with a black smoky flame; in a close tube it yields ammonia. 3. It is not perceptibly dissolved by cold water: it requires 7,000 parts for its solution. 4. It is easily dissolved by acids, and is precipitated from the concentrated solutions by potash or ammonia, in which it is insoluble. 5. Strong nitric acid imparts to it a pale reddish colour, owing to the presence of brucia. 6. Sulphuric acid produces no apparent change in it: but when to the mixture a small crystal of bichromate of potash, of ferricyanide of potassium, or a small quantity of black oxide of manganese or of peroxide of lead is added, a series of beautiful blue, violet, and purple colours appear, which pass rapidly to a light red tint. Among these substances black oxide of manganese will be found preferable. By reason of its insolubility, it imparts no colour to the liquid if strychnia is absent; and if the alkaloid is present it slowly brings out the colours, so that there is time to make full observation. The hydrated or precipitated oxide may be used in place of the anhydrous compound. Permanganate of potash has been recommended as a substitute for the oxide, but it is objectionable on account of its solubility, and of its being already coloured. Dr. Letheby has suggested the use of a small galvanic battery for the production of the coloured reaction. In this case sulphuric acid only is required. It presents no practical advantage over the use of oxide of manganese. 7. Sulphomolybdic and iodic acids produce no change of colour in strychnia, and thus distinguish it from morphia.

The salts of strychnia are very soluble in water, and these solutions give crystalline precipitates, with a large number of substances. The alkalies and alkaline carbonates, if diluted, precipitate the alkaloid in slender prisms (see fig. 62). The sulphocyanide of potassium, ferricyanide of potassium, nitroprusside of sodium, and chromate of potash furnish with it well-defined prismatic crystallizations. In the latter case the crystals are stellated and of a yellow colour. Two of these groups will be found delineated in the annexed illustrations. (Figs. 63 and 64). The chromate of strychnia may be also produced by adding acid chromate of potash to a dialysed liquid containing strychnia. On draining the crystals, drying them, and adding sulphuric acid, the colour reactions are at once brought out. This process has been suggested

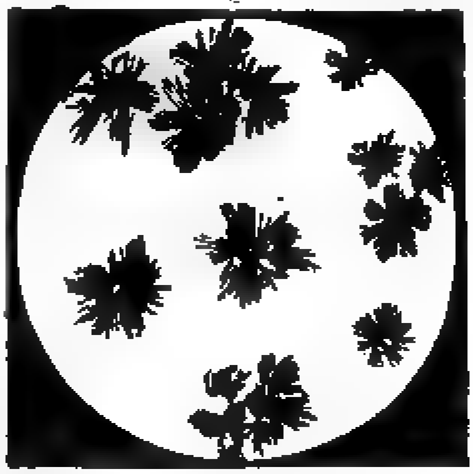
by Mr. Horsley of Cheltenham. Picric or carbazotic acid, recommended by Dr. Guy, is even a more delicate precipitant of a solution of strychnia. It gives small tufts or groups of stellated crystals. According to Dr. James Gray the sulphocyanate of strychnia in crystals may be produced in solutions containing not less than 1-7000th part of strychnia. Dr. Filhol recommends as delicate precipitants of solutions of strychnia, chlorine and chloride of gold, taking care that there is no alcohol in the liquid to be tested. Chloride of gold thus slowly precipitates in a crystalline form even the 1-650th part of a grain of strychnia. When these precipitates, drained of water, are treated with concentrated sulphuric acid, they are dissolved, and to this mixture a crystal of acid chromate of potash may be added to bring out the blue colouration peculiar to strychnia.

Fig. 63.



Crystals of Sulphocyanate of Strychnia magnified 124 diameters.

Fig. 64.

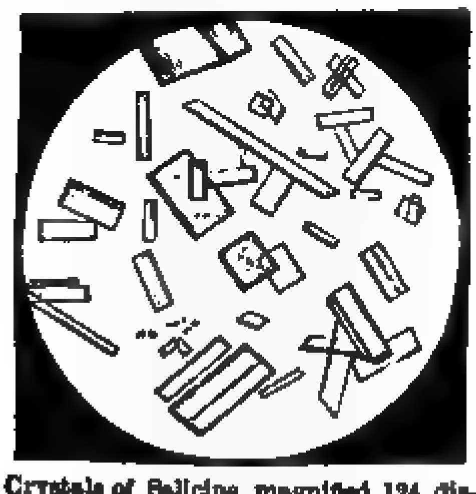


Crystals of Chromate of Strychnia, magnified 124 diameters.

Strychnia has been fatally mistaken for santonine ('Lancet,' 1870, 1, 598), salicine, and jalapine, and has caused death on several occasions. Jalapine does not crystallize, and the crystalline forms of santonine and salicine are, as shown by the annexed illustrations (figs. 65 and 66), very different from those of strychnia.

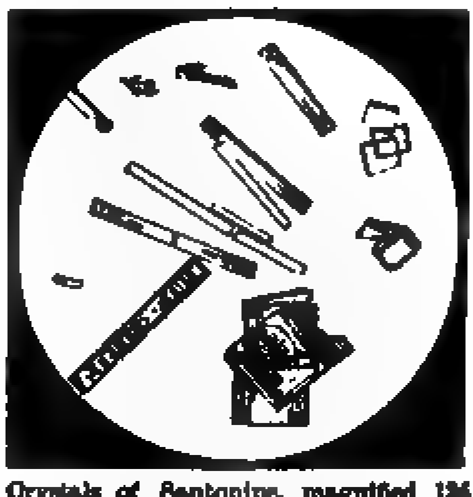
These two vegetable principles differ from strychnia in their properties. When heated in close tubes, they give off *acid* vapours. Salicine is soluble in

Fig. 65.



Crystals of Salicine, magnified 124 diameters.

Fig. 66.



Crystals of Santonine, magnified 124 diameters.

water. Santonine is not soluble in water, but is dissolved by alcohol. Tannic acid and the chloriodide of potassium and mercury do not precipitate the solutions, while they readily precipitate those of strychnia. Nitric acid has no effect upon either, while sulphuric acid, which does not change santonine, gives a pink red colour to salicine. The crystals of santonine closely resemble (in

microscopical appearance) those of salicine, but they are distinguished from salicine and other alkaloids and principles by acquiring a brilliant yellow colour on exposure to sunlight, without undergoing any change of form.

In *Organic mixtures*, a process based on that originally suggested by Stas is generally preferred for the separation of this poison. The principle of its operation consists in dissolving the strychnia by a gentle heat out of the tissue or organ previously pulped or finely cut up, by means of rectified spirit mixed with a small quantity of acetic acid. The liquid is strained, and the residue well pressed and washed with alcohol: the acid solution of strychnia thus obtained is concentrated in a water-bath at a low temperature. The concentrated liquid is neutralized by an alkali, potash or ammonia, the latter being in some respects preferable, and a slight excess of alkali is added. The alkalized liquid is then shaken in a long stoppered tube, with twice its volume of ether or chloroform, or a mixture consisting of two parts of ether and one of chloroform. These liquids dissolve the strychnia set free by the alkali. The ethereal solution is separated from the watery liquid by a pipette or by a stoppered tube, and submitted to spontaneous evaporation, when, if strychnia is present, the alkaloid will be obtained, but generally associated with oily and other organic matters, which interfere with the production of crystals. The impure residue left by the ether is heated in a water-bath, with a few drops of strong sulphuric acid: this destroys the organic matter without materially affecting the strychnia. Water is added, and the acid liquid is filtered through paper, neutralized by ammonia, and again treated with ether, when strychnia will be obtained in small and slender prisms. The crystals, after an examination by the microscope (see fig. 62, p. 411), are treated with sulphuric acid and peroxide of manganese, and the colour reactions of strychnia, if the alkaloid is present, will then appear. By this method I have detected strychnia in the liver of a person who died from this poison, although the organ was in a highly putrescent state. The process of dialysis (p. 215) will allow of the separation of strychnia when combined with acids and in a state of solution, from blood, mucus, and other viscid organic matters found in the stomach. The liquid containing the salt of strychnia may be tested by evaporating a few drops and applying the colour test. If thus found to be present, it may be neutralized by ammonia or potash and shaken with ether or chloroform in order to obtain the strychnia pure. The dialytic process of separation has been most successfully carried out by Dr. Gray of Glasgow. The reader will find in his essay on strychnia a full account of the method of employing this process for the detection of the poison in organic liquids and the best modes of applying the tests. ('STRYCHNIA,' by Dr. James St. Clair Gray, Glasgow, 1872, p. 75.)

The reader will find a full account of the processes for strychnia in organic solids and liquids in some valuable papers published by Dr. Wormley in the 'Ohio Medical Journal,' January 1864, p. 19, and March 1864, p. 119, since republished in his 'Micro-Chemistry of Poisons,' New York, 1867, p. 534. This gentleman describes a case in which, from a misapplication of the process, strychnia was sworn to be present, when, from the chemical method pursued, the alkaloid could not possibly have been separated; and two instances have fallen within my own knowledge recently, where the colours produced by sulphuric acid and bichromate of potash, on the concentrated and dry organic contents of the stomach, were referred to strychnia, when they were really due to the decomposition of the salt employed in contact with organic matter. The detection of this poison in the stomach or the tissues, will depend on the same conditions as those observed in other cases of poisoning. If a person takes a large dose and dies quickly, a residuary portion may be readily found. In *Reg.* v. *Burke* (Clonmel Summer Assizes, 1862), the prisoner administered strychnia to his wife in Epsom salts. She died in about half an hour under

the usual symptoms. Dr. Blyth extracted more than three grains of the poison from the contents of the stomach. If a small dose has been taken, and the person has survived some hours, it is probable that none will remain in the stomach. A decomposed state of the viscera and their contents does not appear to interfere with the detection of this poison. It has been suggested that the presence of morphia counteracts the colour tests: but unless in admixture with the strychnia in large proportion, this is not probable. Besides, in Stas's process, the morphia is not dissolved by the ether.

Persons may die from strychnia, and no trace of the poison be found in the body. In a case of poisoning by this alkaloid, which was the subject of a trial for murder at Perry Co., Pa., in the April term of 1861, Dr. Reese, of Philadelphia, made separate analyses of the contents of the stomach and the contents of the intestines, as well as of the tissues, and each one of these was repeated to avoid all possible error. Yet there was no evidence of the presence of strychnia by the bitter taste of the final extract, or by the colour tests. The witness, by a comparative experiment, satisfied himself that he could detect the half-millionth of a grain ('Amer. Jour. Med. Sci.' Oct. 1861), but in this power of detecting so small a quantity of strychnia in a pure state he had already been anticipated by Mr. W. Copney ('Pharm. Journ.' July 1856, p. 24.) In Dr. Reese's case, the quantity taken was unknown, the woman lived five or six hours, and the body was not examined until six weeks after death. A small but fatal dose, and the duration of the case, will sufficiently account for the negative results without resorting to any other hypothesis. In the case of *Mrs. Salter*, who died from a dose of strychnia in September 1869, death probably took place within two or three hours, but the most careful examination made of the stomach and liver by Mr. Horsley of Cheltenham, led to a negative result. Strychnia, in the opinion of all the medical witnesses, was the cause of death, but no trace of strychnia could be detected in the body by one well qualified to detect it. There was some reason to think that the poison had been taken in solution, but even under these circumstances it must have been rapidly absorbed, diffused, and eliminated.

When death has been caused by small doses applied under the skin, it is not likely that the poison will be found in the tissues. The following experiment was performed in May 1864. One-eighth of a grain of acetate of strychnia in coarse powder was placed in the cellular membrane of the neck of a rabbit. In nine minutes the animal was seized with a sudden convulsion and fell on its side: its fore and hind legs were rigidly stretched out, and its body passed into a state of opisthotonos. It had a succession of fits, and died in one of them in twenty minutes after the commencement of the symptoms. One-half of the powdered acetate was still found in the wound, showing that the rabbit had been killed by the 1-6th of a grain. Of course the residuary strychnia was easily detected in the wound: it was plainly visible to the eye. On applying Stas's process to the heart, as well as the blood and the liver, the tests failed to indicate the slightest trace of the alkaloid. The ethereal liquid left no crystalline residue of any kind. This result does not show that strychnia is not absorbed, but it proves that under certain conditions it cannot be detected in the organs of the body, in cases in which, beyond all doubt, it has destroyed life. In instances in which death has been caused by nux vomica, which contains only one per cent. of the poisonous alkaloid, so far as I know, strychnia has not been found deposited in the tissues.

The following case, which occurred at Liverpool in April 1864, of which the particulars were communicated to me by Dr. J. B. Edwards, shows the rapidity with which the poison may be diffused and deposited in the tissues, when a large dose has been taken. A strong healthy man, æt. 43, placed upon his dry tongue, at 10 P.M., a powder which contained six grains of Dover's

powder and *five grains* of strychnia (dispensed by mistake for five grains of James's powder.) He complained of a bitter taste, asked for an orange, and he found, on sucking this, that it increased the bitterness—the acid juices of the orange instantly dissolved the strychnia, and thus favoured its early absorption. In fifteen minutes he went to bed—twitchings of the muscles then came on, and the patient, from previous experience in taking strychnia as a medicine, was fully aware of the cause of the symptoms. He complained of his bowels being drawn up; he drew his knees up as if to his mouth, gave a yell, seized a friend who was standing by, and became apparently unconscious (exhausted) for about five minutes. He then revived, but in a few minutes was again seized with a violent convulsion of a tetanic character, and he died in two or three minutes afterwards, a little over half an hour after taking the powder. Owing to a spasmodic closure of the jaws, he was able to speak only for a few minutes at a time; he was rational, but seemed to be in great terror. An inspection was made thirty-six hours after death, when the body was found to be unusually warm. The back and lower parts were much discoloured, but the discolouration was easily removed by pressure, indicating a fluid state of the blood. The lower jaw was slightly drawn up, the body straight, not arched; the fingers slightly flexed, not clenched; the thumbs were fixed, but not bent into the palms of the hands. On opening the head, the scalp was found very much gorged with fluid blood. The membranes of the brain were also much congested, as well as the blood-vessels of the brain generally. There was no clot or coagulum, but a quantity of serous fluid escaped from the surface. There was no softening of the substance of the brain or spinal cord. The lungs were healthy, but dark-coloured from engorgement with blood; the heart was empty, its structure was soft; the liver was healthy, the spleen was gorged with fluid blood; the kidneys were congested. The other organs presented no appearance calling for notice. By chemical analysis, Dr. Edwards found strychnia in the stomach, the quantity being estimated at about one grain. He also found the poison in the tongue and the liver. He sent to me a portion of the liver, one kidney, and six ounces of blood. They were in a putrescent state, and, when examined about three months after death, eight ounces of the liver yielded, by the process above described, prismatic crystals of strychnia, producing the usual colour-reactions with sulphuric acid and peroxide of manganese, as well as with bichromate of potash. The quantity of strychnia thus obtained was small. The kidney and the blood did not give results on which any reliance could be placed.

This case shows that a large dose of strychnia rendered soluble will destroy life in half an hour—that within this short time four-fifths may be removed from the stomach, or at least not be discoverable there by careful chemical analysis after death—that in half an hour the poison may be distributed through the body and deposited in the soft organs, although no satisfactory evidence of its presence could be obtained from less than half a pound of animal matter. The strychnia found in the tongue was probably a portion of the powder swallowed, which still remained there. It may be further remarked that, although deceased took in the James's powder 6-10ths of a grain of opium, no morphia was present in the crystalline residue obtained from the liver. (For numerous additional facts and cases connected with this question, see 'Guy's Hospital Reports,' Oct. 1856, p. 326, and 'On Poisons,' 2nd edit. 1859, pp. 70 and 788.)

In the case examined by Casper (p. 406) the deceased admitted that he had taken between five and six grains of strychnia. He lived three hours and a half, and on analysis Dr. Sonnenschein procured from the stomach three grains of the poison. He did not, however, succeed in extracting any from the blood or tissues.

If strychnia has been administered in *pills* and, after death, the stomach has been cut open and the contents lost, there will be little hope of discovering the poison, although in *Reg.* v. *Palmer* (C. C. C., May 1856) some experts affirmed that this state of things would not materially interfere with the chemical process for its detection! The diffusion of the contents of the stomach through the whole of the small and large intestines and their feculent fluids, was treated as a comparatively unimportant matter, only creating some delay in obtaining the results! It need hardly be observed that these are speculative opinions, and that the experts who uttered them had never met with or seen a case by which they could be fairly tested. In those inspections in which there has been such criminal interference or culpable neglect, as in that of *J. P. Cook*, the only course for an analyst is to seek for the poison in the tissues. This case, concerning which so much has been said and written in utter ignorance of the scientific facts, settled nothing in reference to the presence or absence of strychnia in the body of a person poisoned by this substance. Except the actual destruction of the stomach itself, everything had been done which possibly could be done in order to render a chemical analysis utterly fruitless. It cannot therefore be taken as a fair precedent in any sense for the results of a proper medico-legal research in poisoning by strychnia. The greatest reproach to Dr. Rees and myself would have been that we should have detected strychnia under circumstances in which any honest and unprejudiced analyst would have pronounced its detection next to impossible. It is satisfactory to find that a correct view of this remarkable case, and its true bearings on science, have been shown by continental jurists. In an analysis of it, by the late Professor Casper (Horn's 'Vierteljahrsschrift,' Juli 1864, p. 26), not only are the chemical results regarded as negative, by reason of the gross mismanagement of those who inspected the body, but the *post-mortem* appearances themselves, for a similar reason, are considered as throwing no light upon the effects of strychnia on the body. The active co-operation of a professional poisoner, at the examination of the body of his victim, is an exceptional circumstance, even for the liberal customs of this country! It was only the natural course of things that attempts were actually made to defeat a chemical analysis, but when such attempts have proved successful, it is not usual to find scientific witnesses actively struggling for the honour of defending a criminal, not because the deceased did not die from poison, but because it was not chemically detected in his body. The failure of this branch of evidence furnished a favourable opportunity for introducing a variety of ingenious speculations on the cause of death. One of the medical witnesses for Palmer could see in the whole case nothing but angina pectoris, another only epilepsy with 'tetanic complications,' and a third admitted death from poison but not from strychnia, apparently in order to accord with a statement made by the prisoner before execution. These conflicting and dissimilar views would justify the public in placing no confidence in medical opinions. Assuming that there had not been a criminal interference with the dead body on the part of the prisoner *Palmer*, the position assumed—that strychnia, if a cause of death, must always, and under all circumstances, be found in the dead body, is simply untrue. Its detection in the body, properly verified, is a proof that it has been taken; the symptoms in their commencement, progress, and termination will furnish irrefragable proof that it has acted as a poison; but its non-detection does not prove that it has not destroyed life, or, in the words of Casper, 'Das Nichtauffinden des Giftes allein kann, aber niemals einen Gegenbeweis abgehen.'

For a more complete history of the *medical* facts in the memorable case of *Cook*, I must refer the reader to a paper on 'Poisoning by Strychnia,' 'Guy's Hospital Reports,' October 1856. 'Pharm. Journal,' July 1856, p. 6 (from the pen of the late Jacob Bell). The most able legal analysis of it by any

English writer which I have seen, has been published by Mr. J. F. Stephens, in his 'General View of the Criminal Law of England,' 1863, p. 357. Of the foreign reports, one by M. Tardieu, in the 'Ann. d'Hygiène' for 1856, 2, 371, and 1857, 1, 132, and the other by Professor Casper in Horn's 'Viertel-jahrsschrift für ger. Medicin,' &c., 1864, 2, p. 1, are the most correct in their medical and medico-legal details.

Strychnia in Organic Solids.—From the Vermin-killers of Butler and Battle, the strychnia may generally be readily separated by means of alcohol, and procured in a crystalline form for the application of tests. If the vermin-killer is coloured with Prussian blue one or two drops of sulphuric acid will remove the colour, and the oxide of manganese may be added. The colour reactions are then as well marked as with pure strychnia.

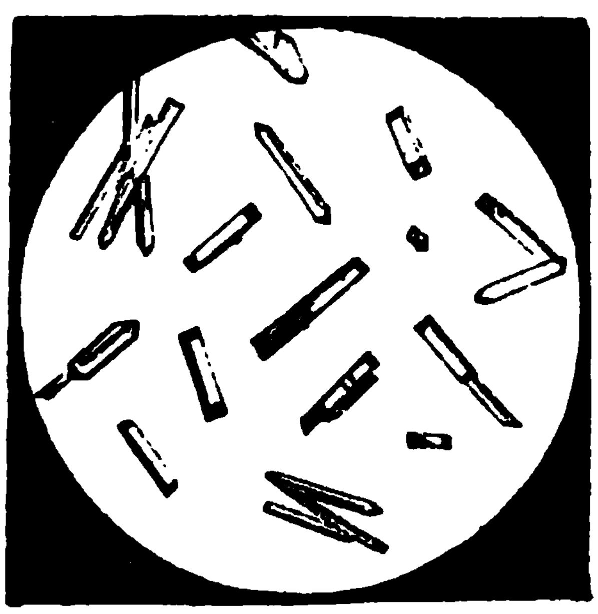
The alkaloids strychnia and brucia may be detected in the powder of nux vomica by the following process:—Digest the powder in a small quantity of diluted sulphuric acid by a water-bath heat. The substance should be well stirred with the diluted acid, which, after a short time, completely carbonizes it. The mass is heated to dryness, then treated with a small quantity of distilled water and filtered, by which an acid liquid of a pale sherry colour is obtained. On neutralizing this liquid with potash or ammonia, and agitating it with two volumes of ether, the strychnia is separated, and may be obtained crystallized by the evaporation of the ethereal solution. The strychnia may also be obtained by dialysis. Ten grains of nux vomica=to 1-10th grain of strychnia, gave satisfactory results. Prismatic crystals were procured which gave the appropriate reactions with the colour tests. Brucia was also detected by the action of nitric acid on the crystals.

In cases in which the poison is contained in pills or powders, having much organic matter soluble in alcohol, it will be advisable to employ either dilute or concentrated sulphuric acid. It is a remarkable fact that strychnia itself is not acted on in the same degree by sulphuric acid as organic matter, or even other poisonous alkaloids.

BRUCIA.

Brucia is an alkaloid generally associated with strychnia. It is contained in the seeds of nux vomica, and more abundantly in the bark of the tree. It is not so powerful a poison as strychnia, but the symptoms which it produces are similar. It is considered to have about one-sixth of the strength of strychnia. It is not affected by the colour-tests employed for the detection of strychnia, and it acquires an intense red colour on the addition of nitric acid. It is more soluble in water than strychnia, and has a bitter taste. Hydrochloric and iodic acids produce in it no change, either in the cold or when heated. Sulphuric acid gives to it a pink red colour without carbonizing it; sulphomolybdic acid the same, but the red colour changes to greenish-brown and ultimately to blue-black. The sulphate of brucia crystallizes in well-defined prisms truncated at the ends. They are larger and longer than the prisms of strychnia.

Fig. 67.



Crystals of Sulphate of Brucia, magnified 124 diameters.

(CEREBRO-SPINAL POISONS.)

CHAPTER 31.

CONIUM MACULATUM. HEMLOCK—CONIA—ŒNANTHE CROCATA—ÆTHUSA CYNAPIUM—ACONITE OR MONKSHOOD. ACONITINA.

COMMON OR SPOTTED HEMLOCK (CONIUM MACULATUM).

THIS is a well-known hedge-plant, which grows abundantly in most parts of Great Britain. Its poisonous properties reside in the seeds, leaves, and roots.

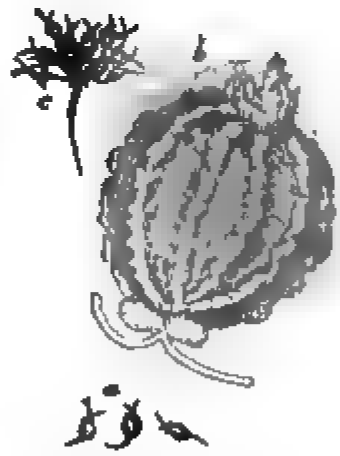
Symptoms and Effects.—The effects produced by hemlock have not been uniform; in some instances there have been stupor, coma, and slight convulsions; while in other cases, the action of the poison has been chiefly manifested on the spinal marrow—*i.e.* it has produced paralysis of the muscular system. A man ate a large quantity of hemlock-plant, by mistake for parsley. In from fifteen to twenty minutes there was loss of power in the lower extremities: but he apparently suffered no pain. In walking, he staggered as if he was drunk; at length his limbs refused to support him, and he fell. On being raised, his legs dragged after him, and when his arms were lifted they fell like inert masses, and remained immovable. There was perfect paralysis of the upper and lower extremities within two hours after he had taken the poison. There was a loss of the power of swallowing, and a partial paralysis of sensation, but no convulsions, only slight occasional motions of the left leg; the pupils were fixed. Three hours after eating the hemlock, the respiratory movements had ceased. Death took place in three hours and a quarter; it was evidently caused by gradual asphyxia from paralysis of the muscles of respiration; but the intellect was perfectly clear until shortly before death. On inspection, there was slight serous effusion beneath the arachnoid membrane. The substance of the brain was soft; on section there were numerous bloody points, but the organ was otherwise healthy. The lungs were gorged with dark fluid blood; the heart was soft and flabby. The stomach contained a green-coloured pulpy mass resembling parsley. The mucous coat was much congested, especially at its greater end. Here there were numerous extravasations of dark blood below the membrane, over a space of about the size of the hand. The intestines were healthy, here and there presenting patches of congestion in the mucous coat. The blood, throughout the body, was fluid and of a dark colour. A portion of the green vegetable pulp was identified as part of the leaves of the *Conium maculatum*. Some of the leaves bruised in a mortar with a solution of potash, gave out the peculiar odour of the alkaloidal principle, conia. ('Ed. Med. and S. J.' July 1845, p. 169.)

In a case which occurred to myself, which was the subject of a trial for murder (*Reg.* v. *Bowyer*, Ipswich Summer Assizes, 1848), the child died in one hour after swallowing part of a teacupful of a decoction of hemlock, alleged to have been administered by the mother. The child sipped the decoction, until it lost the power of holding the cup; it became insensible and paralyzed, and died in the chair in a sitting posture. There were no morbid appearances, and no hemlock leaves were found in the stomach, these having subsided in the cup. The child had been poisoned by the upper stratum of clear liquid. The mother was acquitted for want of proof of administration, the death of the child having taken place in secrecy.

Analysis.—Hemlock is known from most other plants which resemble it by its large round smooth stem, with dark purple spots. The leaves are of a dark-green colour, smooth and shining. Every portion of the plant has a

peculiar and disagreeable smell when rubbed or bruised, resembling cat's urine, or, according to some, the odour of mice. It is strongly brought out when the stem, leaves, or seeds are rubbed with a solution of caustic potash. We subjoin an illustration of the *seeds* of hemlock, which are peculiar in their form, and are easily distinguished from the seeds of other umbelliferous plants (Fig. 68). A person may be poisoned by a decoction of *leaves* of hemlock, and no leaves be found in the stomach or bowels (case of *Bowyer*, supra). In this case the stomach had been emptied, and the contents lost before it was sent to me! No trace of conia was found. The prisoner first gathered the *Anthriscus sylvestris* by mistake for *Conium maculatum*, but it was proved that she had afterwards gathered the leaves of hemlock. A leaf of each of these plants was copied by photography, and produced as evidence in Court.

Fig. 68.



a. Seed of Hemlock, natural size.
b. The same, magnified 20 diameters.
c. Group of Seeds.

As the determination of the presence of fragments of leaves in poisoned liquids, and in the contents of a stomach, may be of importance in evidence, an illustration of hemlock-leaves, engraved from a photograph of the living plant (Fig. 69) is subjoined. The appearance and smell of the leaves, either when bruised or when rubbed with a solution of potash, will greatly aid a medical witness in forming a judgment, as there are many umbelliferæ which bear a close resemblance to hemlock in the form of their leaves. Among these, however, it is impossible to rank common parsley. It is hardly credible that a mistake of this kind should be made, yet through carelessness and ignorance accidents have occurred. In August 1864, a lady and two of her children, residing in the neighbourhood of Liverpool, were seized with symptoms of poisoning soon after dinner. The medical gentlemen who were called in examined the remains of some soup which had been eaten for dinner, and they detected fragments of the leaves of hemlock amongst the herbs which had been used to flavour the soup. Under treatment, the symptoms abated in a few hours, but these persons did not entirely recover until after two or three days. It turned out that the hemlock had been gathered in the garden belonging to the family, where it was growing side by side with parsley. As the parsley was raised from seed, it is probable that hemlock-seed had been accidentally mixed with it by the seedsman, and thus the accident had occurred. We subjoin an illustration from a photograph of a leaf of parsley; also illustrations of the seeds, by which the differences between hemlock and parsley will be at once apparent (Figs. 70 and 71).

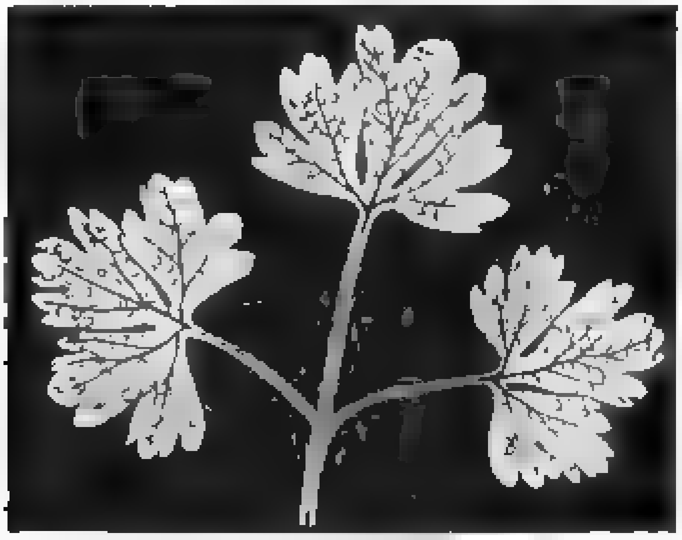
Fig. 69.

Leaf of Common Hemlock.

Conia.—The alkaloid of hemlock is known under the names of conia, conein, conicine, and conicina. It resembles nicotina and ammonia in its liquidity, alkalinity, volatile reaction, and in some of its chemical properties. It is a liquid of oily consistency, of a pale yellow colour, powerfully alkaline, and has, when its vapour is diluted, a smell resembling that of mice, and an acrid bitter

taste. It gives a volatile greasy stain to paper, and burns with a yellow flame and thick smoke. 1. It is not coloured or affected by nitric, sulphuric, or hydrochloric acid; the last-mentioned acid produces with it dense white fumes

Fig. 70.



Leaves of Garden Parsley, from a photograph.

Fig. 71.

Seeds of Garden Parsley.
a. Natural size.
b. Magnified.

of hydrochlorate of conia, and on heating the mixture, this salt remains in prismatic crystals. 2. It is not dissolved by water, but floats on it in oily globules. 3. It is soluble in alcohol and ether, and this last-mentioned liquid removes it from its aqueous solution, and leaves it in oily globules on evaporation. 4. It gives a white precipitate with corrosive sublimate, and a yellow precipitate with arsenio-nitrate of silver. 5. It precipitates brown oxide of silver from the nitrate; this is not dissolved by an excess, but the oxide is blackened and reduced. 6. Iodine water gives a reddish-brown precipitate, which is redissolved; an excess of iodine water causes a yellowish precipitate. 7. It gives a yellow crystalline precipitate with chloride of gold, but no precipitate with chloride of platinum. 8. Tannic acid precipitates it of a dingy white. 9. Gallic acid gives no precipitate, but slowly acquires a yellowish colour. Its odour and insolubility in water, as well as several of the characters above mentioned, serve to distinguish it from nicotina and ammonia; but it may be readily separated from ammonia by the chloriodide of potassium and mercury, which precipitates it even more completely than tannic acid. Conia discharges the colour of a solution of permanganate of potash more readily than ammonia, but more slowly than nicotina. In reference to its presence in *organic mixtures*, it may be detected by its peculiar odour, or by distilling the liquid with a solution of potash and examining the distillate.

The reactions produced by tests on small quantities should be distrusted, unless there is strong corroborative evidence of the action of the poison on the body from the symptoms. As in reference to strychnia, veratria, and other alkaloids, an incautious operator may readily come to the conclusion that he has found 'traces,' and ascribe death to the poison. The following case occurred in Germany a few years since. A man died very suddenly, *i.e.* in two hours and a half after going to bed, and it was alleged that his wife had poisoned him. The persons commissioned to make the analysis deposed that they had found traces of conia in the stomach, intestines, and kidneys, and they came to the conclusion that the man had died from the effects of hemlock, which implicated his wife in a charge of murder. Some doubt appears to have arisen in the minds of the authorities on this point, and they submitted three questions for the consideration of a Medical College. 1. Is there any reason to doubt whether conia has really been found in the body of deceased? 2. If existing in the body, may it have been spontaneously produced, or does it show

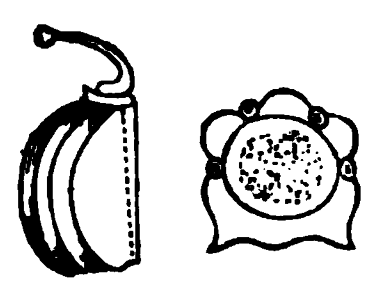
administration from without? Does its detection in the body incontestably prove that the deceased died from poisoning by conia or hemlock? 3. Is it improbable that deceased poisoned himself with hemlock? The College decided that there was not sufficient evidence to show that death had been caused by hemlock. The matter was then referred to Mitscherlich and Casper of Berlin, and they found that the chemical processes pursued failed to detect conia in the body—that there was nothing to indicate that deceased had taken hemlock or conia in any form, and that the state of the windpipe sufficiently accounted for the sudden death of deceased. He had eaten and drunk freely, had vomited after going to bed; a portion of the food had entered the trachea and had suffocated him! (See Casper's 'Vierteljahrsschrift,' 1859, p. 194.)

Water-Hemlock (Cicuta virosa).

The water-hemlock has given rise to several fatal accidents, its roots having been mistaken for parsnips. The whole of the plant is poisonous; but the roots are the most active, especially when gathered early or late in the year.

Symptoms and Effects.—The symptoms produced by the roots are giddiness, dimness of sight, headache, and difficulty of breathing. There is burning pain in the stomach, with vomiting, and these symptoms are accompanied by heat and dryness of the throat. Convulsions have been observed to precede death. In the cases of three children, who died in convulsions from this poison, Mertzdorff found an injected state of the mucous membrane of the stomach, with redness of the air-passages, as well as of the stomach at the cardia and pylorus. The vessels of the brain and the sinuses were filled with dark liquid blood. (Wibmer, 'Cicuta,' p. 119.) In a fatal case which occurred to Wepfer, the patient, a man, æt. 20, who had eaten a large quantity of the *root*, was found with his face swollen and his eyes projecting. He breathed with great difficulty, and foamed at the mouth. He was seized with a severe epileptic fit: his limbs assumed a tetanic stiffness, and there was spasmodic breathing. He was quite unconscious, and soon died. The only marked appearances were fluidity of the blood, and patches of redness on the mucous membrane of the stomach. (Wibmer, loc. cit.) A man ate a portion of the root of this plant in a cooked state. It had a sweetish taste, and was of the colour of a parsnip. Half an hour after his dinner he felt giddiness and great dryness of the throat. He walked home with great difficulty, his legs being very unsteady, and all surrounding objects appeared to him as if they were advancing or receding. In about an hour and a half the legs were paralysed—the arms numbed, and their movements weak; the face was anxious and flushed, and he had an apprehension of death. The skin was warm and dry—the pulse 90. An emetic was given. In two hours he was able to stand, and with difficulty walked across the room. He passed much urine, and had hallucinations. In seven hours the legs were cold, pupils dilated, skin and throat dry, with occasional delirium. There was no purging. In two days he recovered. ('Lancet,' 1871, 2, 396.) In the 'Pharmaceutical Journal' for June 1872, p. 1063, two fatal cases are reported to have occurred at Chester. The boys ate the roots, supposing them to be wild celery. Symptoms of poisoning soon came on. They suffered from severe convulsions with trismus (lock-jaw) before death.

Fig. 72.



Seed of Cicuta virosa, magnified (Lindley).

Hemlock Water-Dropwort (Œnanthe crocata).

This umbelliferous plant grows on the banks of rivers, streams, and ditches. It is one of the most poisonous of the order, and is considered to be one of the most virulent of English vegetable poisons.

Symptoms and Appearances.—A set of cases of poisoning by œnanthe was communicated to the 'Medical Gazette' (vol. 34, p. 288), by Mr. Bossey, of Woolwich. A number of convicts, while engaged at work, ate the leaves and roots of the œnanthe. In about twenty minutes one man, without any apparent warning, fell down in strong convulsions, which soon ceased, but left a wild expression on his countenance. Soon afterwards, as many as nine fell into a state of convulsions and insensibility. The face of the man first seized became bloated and livid, there was a bloody foam about the mouth and nostrils, the breathing was stertorous and convulsive, and there was great prostration of strength with insensibility: he died in five minutes after the symptoms had set in. A second died under similar symptoms in a quarter of an hour, although the stomach-pump was used, and some leaves were extracted with the fluids. A third, who had assisted in carrying the two former, was himself seized with convulsions, and died in about an hour; and soon after him, a fourth died, in spite of the most energetic remedial treatment by cold affusion, emetics, stimulants, stimulating frictions, as well as the use of the stomach-pump. Two other cases proved fatal, the one in nine days, and the other in eleven; and in these two cases there was irritation of the alimentary canal. On inspecting the bodies of those who died quickly, there was congestion of the cerebral vessels; and, in one instance, a layer of extravasated blood was found beneath the inner membrane (pia mater). In the first case, which proved most quickly fatal, the cerebral vessels were not congested. The pharynx and gullet had a white appearance, and contained some mucus, with portions of the root. The lining membrane of the windpipe and air-tubes was intensely injected with dark blood. The lungs were gorged with fluid blood. The blood in the heart was very black and fluid. The stomach and intestines were externally of a pink colour: the cavity of the stomach [illegible] lined with a thick viscid mucus, containing portions of the root. The [illegible] membrane was much corrugated, and the follicles were particularly [illegible] Similar appearances were met with in all. In the two protracted [illegible] mucous membrane of the stomach and bowels was softened and thick[illegible] had a pink colour externally, but no red appearance internally. The [illegible] of the brain were congested. In the others who partook of the [illegible] symptoms were not so severe. Under the free use of purgatives, a con[illegible] able quantity of the root was discharged, and in a few days the men recove[illegible] These cases show that the œnanthe is a powerful poison. It destroys life [illegible] even greater rapidity than arsenic; for it here proved fatal to a strong hea[illegible] man in less than *one hour.* Chemists have not yet ascertained on what [illegible] ciple its active properties depend, but they appear to reside chiefly in the [illegible]

In April 1857, two fatal cases occurred at West Boldon, in Durham: [illegible] labourers ate some of the roots of the œnanthe. They were found soon [illegible] wards lying insensible and speechless, their faces livid, tongues swoll[illegible] protruded, and there were convulsive movements of their teeth, frothy [illegible] with blood about their mouths, eyes full and projecting, pupils dilated, brea[illegible]ing stertorous and laboured, with occasional general convulsions. They both died in an hour and a half from the time at which they were first discovered. On *inspection* it was found that there had been bleeding from the ears; the abdomen was livid and swollen. The stomach contained a gruelly liquid with some of the partly digested roots: on removing this liquid, the membrane was found congested and softened. The lungs were engorged with dark liquid blood, and the blood contained in the heart was in a similar state. Mr. Boyle, to whom these cases occurred, forwarded to me a portion of the roots, and there was no doubt that they were the roots of the œnanthe crocata.

It is not often that attempts are made to destroy others by the administration of these vegetable poisons; but a case occurred in France, in which a

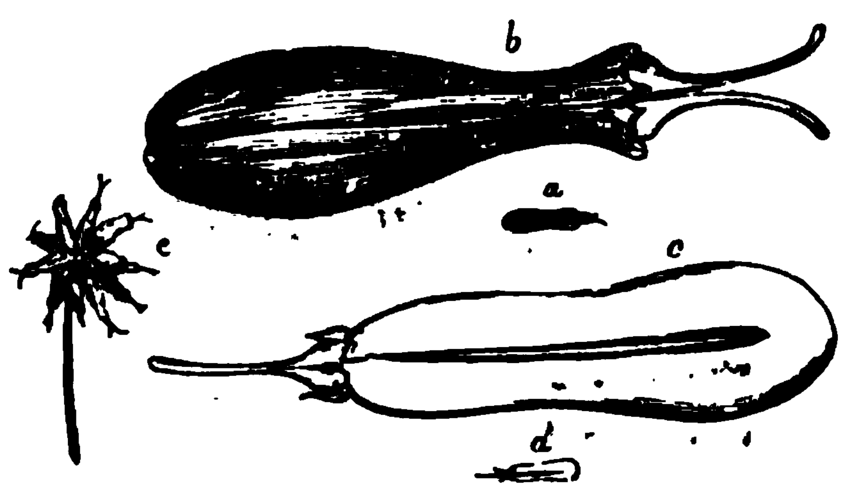
woman attempted to poison her husband by mixing slices of the root of this plant with his soup. His suspicions were excited by the acrid taste of the soup. The woman was tried for the crime, and M. Toulmouche deposed at the trial that the plant from which the root had been taken was the œnanthe crocata—that it was a powerful poison, and might cause death in two or three hours. The prisoner was convicted, and condemned to ten years at the galleys. ('Gaz. Med.' Jan. 3, 1846, p. 18; also Jour. de Chim. Méd.' 1845, p. 533.) The œnanthe is poisonous to animals. In March 1868, five bullocks and one sheep were poisoned by eating some roots of this plant, near Helstone, in Cornwall. The roots had been dug up, and thrown in a heap in the field where the cattle were pastured.

Analysis.—The œnanthe crocata can be identified only by its botanical characters. The leaves are of a dark green colour, with a reddish-coloured border. They have no unpleasant odour when rubbed. The plant bears a greater resemblance to celery than most of the other umbelliferæ. Its stem is channeled, round, smooth, and branched, of a yellowish-red colour, and growing to the height of two or three feet. The root consists of a series of oblong tubercles with long slender fibres. It is of a yellowish-white colour, and not unpleasant to the taste. It is the most active part of the plant. The leaves yield much tannic acid to water, but the decoction appears to contain no alkaloidal base, since the chloriodide of potassium and mercury produces no precipitate in it. The roots and stems of this plant are more frequently eaten than the leaves. Nevertheless, it may be occasionally necessary to identify the plant by the leaves. The annexed engraving (Fig. 73) is taken from a photo-

Fig. 73.

Part of leaf of Œnanthe.

Fig. 74.



Seeds of Œnanthe crocata.
a. Natural size.
b. Magnified 80 diameters.
c. One half of a seed magnified.
d. One half natural size.
e. Group of seeds.

graph of the larger leaves of the œnanthe crocata, grown from the roots of the plant procured from the spot where the two labourers above mentioned had taken their fatal meal. The smaller leaves of this plant are much wider in proportion to their length.

Fool's Parsley (Æthusa cynapium).

Fool's Parsley, or Lesser Hemlock, is very common in gardens and hedgerows. The leaves so closely resemble those of parsley that they have often been gathered for them by mistake.

Symptoms and Appearances.—That the root of this plant contains a most energetic poison, and that it is capable of producing rapidly fatal effects, is proved by a case reported by Mr. Thomas, in which death took place in an hour. In May 1845, a girl, aged five years, in good health, ate the bulbs of the æthusa by mistake for young turnips. She was suddenly seized with pain in the abdomen, followed by sickness, but no vomiting. She complained of feeling very ill. On trying to eat, she could not swallow. She was incapable of answering questions, and her countenance bore a wild expression. The lower jaw was so fixed by spasm as to prevent anything being introduced into the mouth. She then became insensible, and died in *an hour* from the commencement of the symptoms: so far as could be ascertained, there were no convulsions. A second child, aged three years, shortly after eating the same substance, was attacked with pain in the stomach, sickness, vomiting, and profuse perspiration. She soon recovered, with the exception of suffering severe griping pains without purging, but these disappeared on the following day. A third child, of the same age, suffered from similar symptoms. Recovery in the two last cases was due to the plant having been eaten on a full stomach, and to the effect of early and copious vomiting. ('Med. Times,' Aug. 23, 1845, p. 408.) The following case occurred to Mr. Stevenson: Two ladies partook of some salad, into which the leaves of this plant had been put by mistake for parsley. They soon experienced nausea, with occasional vomiting; oppressive headache, giddiness, and a strong propensity to sleep, at the same time that this was prevented by frequent startings and excessive agitation. There was a sensation of pungent heat in the mouth, throat, and stomach, with difficulty of swallowing, thirst, and loss of appetite. There was numbness, with tremors of the limbs. The two patients only slowly recovered from the effects of the poison. (Churchill's 'Botany.')

Analysis.—It is known from garden parsley by the smell of its leaves when rubbed, which is peculiar, disagreeable, and very different from that possessed by the leaves of parsley. The leaves of Fool's Parsley are finer, more acute,

Fig. 75.

Portion of a leaf of Fool's Parsley, natural size.

Fig. 76.

Seeds of Fool's Parsley.
a. Natural size.
b. Magnified 10 diameters.
c. Group of seeds.

and of a darker green colour. They are represented in the annexed illustration, from a photograph of the living plant (Fig. 75). Its flower-stem, which is striated, or slightly grooved, is easily known from all other umbelliferous plants by the beard, or three long pendulous leaves of the involucrum under the flower. The flowers are white, those of the garden parsley of a pale yellow colour.

The poisonous properties of this plant are believed to be due to an alkaloid, *æthusin*, the chemical characters of which have not been clearly defined.

Monkshood (Aconitum Napellus).

This well-known garden plant is in some parts of the country called *Wolfsbane*, and in Ireland *Blue-rocket*. The roots, seeds, and leaves are highly poisonous, owing to the presence of the alkaloid *aconitina* or *aconitia*; the root is especially noxious, and when the leaves have fallen off, it appears to possess its greatest virulence. These parts of the plant, when masticated, produce a cool numbing sensation, affecting the lips, tongue, and interior of the mouth generally. At first the root appears to be tasteless, as the effects are only manifested after twenty minutes or half an hour. From tasting only a small portion of the dried root, I found that this disagreeable sensation remained on the tongue and lips for four hours. In larger quantity the taste has been described as burning, and it is stated to have been followed by a hot acrid sensation in the throat.

Symptoms and Appearances.—In from a few minutes to an hour after the poison has been taken, the patient complains of numbness and tingling in the mouth and throat, which are parched:—there is giddiness, with numbness and tingling in the limbs, a loss of power in the legs, sometimes frothing at the mouth and severe pain in the abdomen, followed by vomiting and purging. In some cases the patient is completely paralyzed, but retains his consciouness: in others the giddiness is followed by dimness of sight, delirium, and other cerebral symptoms, but not amounting to the complete coma produced by the cerebral or narcotic poisons. The pupils are dilated, the pulse sinks, the skin is cold and livid, and the breathing is difficult. Convulsions are not commonly observed in man, or they are indicated by general tremors or twitchings of the voluntary muscles. The poison produces convulsions in animals.

Root.—Poisoning by the *root* of aconite is by no means unfrequent. In the spring or autumn, the root is liable to be mistaken for that of horseradish. It has been thus accidentally eaten on several occasions, and has caused death. A mistake of this kind led to fatal results in three hours in a case which occurred at Lambeth; and another set of cases occurred at Dingwall, in Scotland, in January 1856. Here three persons were poisoned by reason of their having had sauce made with the root of aconite, served at dinner with roast-beef in place of horseradish sauce! They were healthy adults; they all died within three hours and a half. Mistakes of this kind show deplorable ignorance, but there is always the risk of their occurrence when horseradish and aconite are grown near to each other in a garden, at that season of the year when the leaves have fallen. A trial for murder by poisoning with the root of this plant took place at the Monaghan Lent Assizes in 1841 (*Reg.* v. *McConkey*), in which the late Dr. Geoghegan of Dublin conducted the medico-legal investigation. The medical evidence was beset with difficulties; for no trace of the poison could be discovered in the body, and it was only by a close analysis of symptoms and appearances that the charge was brought home to the prisoner. The deceased had eaten for his dinner some greens dressed for him by the prisoner; he complained of their having a sharp taste, and this was perceived also by another person present who tasted them. It was ascertained that the deceased, soon after the meal, had vomited a greenish matter, and suffered from purging, restlessness, incoherence, lock-jaw, and clenching of the hands. He died in about three hours after having eaten the greens, but was not seen by a medical man while living. The chief appearance met with was in the stomach, where the mucous membrane was of a light reddish-brown colour. Traces of vegetable matter were found in the intestines: but no poison could be detected, either botanically or chemically. The symptoms suffered by a friend of the deceased, who had accidentally tasted the greens, were very characteristic of poisoning by aconite. In *two* minutes he felt a burning heat in the mouth, throat, gullet, and stomach; then a sensation of swelling in the face, with a

general feeling of numbness and creeping of the skin. Restlessness, dimness of sight, and stupor almost amounting to insensibility, followed; and in about an hour after the meal he was found speechless—frothing at the nose and mouth, the hands and jaws clenched, appearing occasionally as if dead, and then again reviving. Vomiting, purging, tenderness at the pit of the stomach, cramps, tingling of the flesh, and a burning taste in the mouth followed. This man did not entirely recover until after the lapse of five weeks. The prisoner was convicted of murder, and confessed before her execution that the powdered *root* of aconite had been mixed with pepper and sprinkled over the greens. ('Dublin Med. Journal,' vol. 19, p. 403.)

It is stated that one drachm of the dried root has proved fatal: but it is probable that less than this would cause death. In November 1856, Mr. Hadfield forwarded to me four small slices of aconite root, taken from the stomach of a man who had died in three hours. The quantity which he had swallowed with suicidal intention was unknown: but none was thrown off by vomiting so far as could be ascertained. The *symptoms* within half an hour of death were burning pain in the stomach, parched mouth, intense thirst, retching and vomiting of a tenacious mucus, cold perspiring skin, imperceptible pulse, and a feeling of deadly sickness. The patient was conscious: there were no convulsions. On *inspection*, there was congestion of the brain as well as of its membranes; the heart was flaccid, and there was some blood on the right side. The stomach contained much half-digested food, with four slices of aconite root apparently unaltered. The mucous membrane presented a slight reddish-brown patch at the greater end, of the size of half-a-crown. It was otherwise healthy, as well as the other organs. (For an account of the effects of this plant I must refer the reader to a paper in the 'Dub. Jour. Med. Sci.' vol. 19, p. 403.)

The tincture of the root operates powerfully in small doses. The late Dr. Male of Birmingham, died from the effects of not more than *eighty drops* taken in ten doses, over a period of four days, the largest quantity taken at once being *ten* drops. ('Prov. Med. and Surg. Journ.' August 20, 1845, p. 535; also 'Med. Gaz.' vol. 36, p. 861.) The late Dr. Pereira informed me that he had known tingling and general numbness of the limbs produced in hysterical women by a dose of only *five minims* of a carefully prepared tincture. Dr. Topham has published an account of the symptoms produced by *fifteen minims* of the tincture of the root of aconite. Immediately after taking the poison in a mixture into which it was put by mistake, the patient (a woman, æt. 27) felt a sensation of numbness in the tongue, with difficulty of swallowing. There were convulsive twitchings of the muscles of the face, and she lost the power of walking. There was complete unconsciousness, which continued for two hours, when she began to recover. The pupils were observed to be slightly contracted. The intensity of the symptoms varied at intervals, and came on in paroxysms. They indicated great disorder of the nervous system. The next day she had numbness in both arms, but she rapidly and perfectly recovered. ('Lancet,' July 19, 1851, p. 56. See also the account of a case of recovery in 'Amer. Journal of Med. Sci.' January 1862, p. 285.)

In January 1853, a woman took by mistake *seventy minims* of *Fleming's tincture* of the root mixed with one grain of acetate of morphia. In a few minutes she became very thirsty, complained of a burning sensation and pain in her stomach, to relieve which she swallowed a quantity of cold water. In fifteen minutes there was violent vomiting, which continued for two hours. She lost the power of standing, and was very restless. The pain in the stomach increased, and there were convulsive movements of the muscles. She was conscious until shortly before her death, which took place in about four hours after she had taken the poison. There were no general convulsions: the pain in the stomach was well marked throughout. On *inspection*, the

membranes of the brain were found congested, but the brain itself was firm and healthy. The lungs were healthy: the heart was flaccid, and the uterus congested. The stomach contained some mucus, and the membrane at the larger curvature was injected (reddened) in patches, but otherwise natural. The mucous membrane of the duodenum was in a high state of inflammation, abraded in patches, softened and broken down. Some spots were of a very dark colour, passing into mortification. In October 1852 an excise officer lost his life by merely tasting Fleming's tincture of aconite, under the supposition that it was flavoured spirit. He was able to walk from the Custom House over London Bridge, but he died in about four hours after taking the poison. A liquid sold for external use under the name of NEURALINE appears to be a preparation of tincture of aconite mixed with chloroform and rose-water. According to Dr. Harley there is one drop and a half of Fleming's tincture in half a bottle of the so-called neuraline. It operates by causing numbness or paralysis of the parts to which it is applied. The death of the *Hon. G. R. Vernon* was ascribed to the too frequent use of this preparation externally. ('Pharm. Jour.' Jan. 1872, p. 618.) The same ignorance prevails respecting this as with regard to other poisonous substances dissolved in alcohol, namely, that it is harmless unless the skin is broken. Unless it were absorbed by the skin it could have no medicinal operation, and the effects of absorption must depend on the quantity applied and the frequency with which it is applied. Alcohol has been found to promote the absorption of poisonous agents through the unbroken skin.

The case of the man *Hunt* who, in November 1863, destroyed his wife and children by prussic acid, presents some features of interest in reference to the symptoms and appearances produced by tincture of aconite. The quantity of tincture taken by him was not determined; but the man was soon afterwards seized with violent spasmodic retching, face pale, skin cold and clammy, pulse small and hardly perceptible, and the action of the heart feeble. The pupils were much dilated, and the eyes brilliant and sparkling; the breathing quiet and regular, except during the fits. He complained of pain in his heart. In attempting to walk, he staggered, and had no power to raise his arms. He was perfectly conscious, called for writing materials, and wrote a few lines. He then became suddenly worse, and a quarter of an hour before his death he lost all power and sensation in his limbs, the sharpest pinches producing no impression. The pulse was imperceptible. There were no convulsions, but complete relaxation of the limbs at death, which appeared to arise from syncope three-quarters of an hour after he had taken the poison. On *inspection* forty-two hours after death, there was great rigidity of the muscles. The substance of the brain was firm and healthy: the vessels on the surface were filled with blood. The heart was healthy: the right side was greatly distended with dark fluid blood; the left side contracted and quite empty. The lungs were healthy. In the abdomen the viscera were healthy, with the exception of the stomach and duodenum. Mr. Puckle, to whom I am indebted for the above particulars, brought the stomach to Guy's Hospital, and we examined it together. There was great capillary congestion at the larger end of the stomach, the mucous membrane having a bright red colour. There were marks of irritation, with softening and separation of the mucous lining, the whole of the membrane being in a highly corrugated condition. Traces of aconitina were found in the contents of the stomach. The deceased had provided himself with an ounce of the tincture of aconite, and had swallowed the greater part of this mixed with water.

The tincture varies much in strength. In the 'Lancet,' vol. 2, 1861, p. 170, it is stated that a lady recovered who had swallowed two teaspoonfuls by mistake for laudanum. She had been in the habit of taking large doses of laudanum. After she had swallowed the aconite she could not rise from her seat, and ex-

claimed that she had lost the use of her legs. She complained of a burning sensation in the throat and constriction at the chest. Her mind was clear, and she had the consciousness of no feeling in her arms and legs. The symptoms subsided in two hours, and she recovered in eight hours. Vomiting had been early promoted by emetics. In November 1862, a case was communicated to me by Dr. Vachell, of Cardiff, in which a man died from the effects of two grains of the extract of aconite taken in two pills. As in other cases in which active poisons have been administered in pills, the symptoms were a long time in appearing, but when they once commenced they proceeded rapidly to a fatal termination.

A well-marked case of poisoning by a *decoction* of this plant occurred to Mr. Sayle. A man, æt. 39, boiled the fresh stalks and leaves of aconite in half a pint of beer until it was reduced to a quarter of a pint: he then swallowed half of it as a medicine. An hour afterwards he was found in bed, rolling his arms about and foaming at the mouth:—the pupils were widely dilated, the legs were paralyzed, the skin was cold and clammy, there was great nausea, the pulse was scarcely perceptible, and he was perfectly insensible. He soon afterwards died. The abdomen was examined, and the only appearance met with was a slight redness near the cardiac extremity of the stomach. ('Med. Times,' Oct. 18, 1845, p. 70.)

Analysis.—The botanical characters of the root and leaves, when any portions can be obtained, will enable a medical witness to identify this vegetable poison. The root has been frequently and fatally mistaken for horseradish, but there are these striking differences:—1. Aconite-root (Fig. 77) is very short, conical, and tapers rapidly to a point. 2. It is externally of an earthy-brown colour,—internally white and of an earthy smell,—the cut surface is rapidly reddened by exposure to air. It has numerous long thin fibres proceeding from it. 3. It has at first a bitter taste, but after a quarter of an hour or twenty minutes it produces a disagreeable sense of tingling and numbness on the lips and tongue. 1. Horseradish root (Fig. 78) is long, cylindrical or nearly so, and of the same thickness for many inches. 2. It is externally whitish-yellow, and has a pungent odour when scraped. 3. Its taste is sometimes bitter, but it produces an immediate hot or pungent sensation.

Fig. 77.
a

a. Root of Aconite.

Fig. 78.
b

b. Root of Horseradish.

The leaves of aconite or monkshood are of a dark-green colour, thick and of a

peculiar shape. The illustration below (Fig. 79) is engraved from a photograph of a fresh leaf. When masticated the leaves slowly produce on the lips and tongue the persistent sensation of tingling and numbness, with the sense of coolness, observed in the root. They are less powerful than the root and seeds. The seeds differ in appearance from those of other poisonous plants. (See Fig. 80.)

Fig. 79.

Small leaf of Aconite, natural size, from a photograph.

Fig. 80.

a. Seed of Aconite, natural size.
b. The same, magnified 30 diameters.

Aconitina.—The alkaloidal base of this plant, *Aconitina* or *Aconitia*, is a formidable poison, exceeding all others in its effects. In one case one-fiftieth part of a grain nearly proved fatal to an elderly lady (Pereira, 'Mat. Med.' vol. 2, pt. 2, p. 695); and it is probable that *one-tenth* part of a grain of pure aconitina would prove fatal to a human being. Some samples of this alkaloid are, however, much less potent than others, and the chemical properties are also different. (See paper by Schroff, 'Reil's Journal für Toxikologie,' 3rd H. 1857, p. 335), and one by Liégeois ('Chem. News,' Oct. 24, 1863, p. 201). This contains the account of a simple method for the extraction of the alkaloid.

Analysis.—A sample of English aconitina possessed the following properties:—It was in whitish granular masses, without any distinctly crystalline structure. 1. When heated it readily fused and burnt in the air with a bright yellow flame. 2. Heated in a close tube, it evolved first an alkaline and then an acid vapour. 3. It was scarcely soluble in water, but was dissolved by weak acids and alcohol: it did not readily crystallize. 4. Nitric acid dissolved it without causing any change of colour. 5. Sulphuric acid gave to it a yellowish colour, and green oxide of chromium was separated on adding to it a crystal of bichromate of potash. Aconitina cannot be readily separated from its solutions in a crystalline state by the addition of ammonia. 6. Tannic acid and the chloriodide of potassium and mercury precipitate the alkaloid.

Aconitina is sufficiently soluble in ether to allow of its separation from *organic liquids* by the process of Stas (see page 413). Dr. Headland recommends as a physiological test, the production of an alcoholic extract of the contents of the stomach and its application to animals. One-twentieth of a grain will be sufficient: the 1-300th of a grain will poison a mouse; the 1-100th, a bird; and 1-1000th causes tingling and numbness of the tip of the tongue. The 1-000th of a grain dissolved in spirit and rubbed into the skin, causes local loss of feeling, lasting for some time. ('Lancet,' March 29, 1856, p. 343.) There is a great difference in the properties of this alkaloid according to the mode in which it is prepared. (Bouchardat, 'Ann. de Thérapeutique,' 1864, pp. 48 and 54; also, 'Annuaire,' 1863, p. 41.)

CHAPTER 32.

ATROPA BELLADONNA OR DEADLY NIGHTSHADE—POISONING BY ATROPIA—LOBELIA —FOXGLOVE. DIGITALINE—DATURA STRAMONIUM, OR THORNAPPLE—DATURA ALBA AND FASTUOSA. DATURIA. LABURNUM — TAXUS BACCATA OR YEW. LIGUSTRUM OR PRIVET—ILEX AQUIFOLIUM OR HOLLY—VIBURNUM OPULUS OR GUELDER ROSE.

Deadly Nightshade (Atropa belladonna).

Symptoms.—The symptoms which are produced by the leaves, berries, and root of belladonna are of a uniform character, and, as a summary, they may be thus described :—Heat and dryness of the mouth and throat, nausea, vomiting, giddiness, indistinct or double vision, delirium, great excitement and restlessness, convulsions followed by drowsiness, stupor, and lethargy. The pupils are much dilated, and the eyes are insensible to light. In two cases which occurred to Mr. Tufnell, the pupils were contracted during sleep, although dilated in the waking state. ('Dublin Med. Press,' Jan. 5, 1853; 'Journal de Chimie Médicale,' 1853, p. 695.) Several deaths from the poisonous effects of the *berries* occurred in London in 1846. The following case was admitted into Guy's Hospital :—A boy, æt. 14, ate, soon after breakfast, about thirty of the berries of the belladonna, which he had bought as fruit in the streets. In about three hours he had the sensation of his face being swollen : his throat became hot and dry, his vision was impaired, objects appeared double, and they seemed to revolve and run backwards. His hands and face were flushed, and his eyelids swollen; there were occasional flashes of light before his eyes. He tried to eat, but could not swallow on account of the state of his throat. In endeavouring to walk home he stumbled and staggered; and he felt giddy whenever he attempted to raise his head. His parents thought him intoxicated : he was incoherent,—frequently counted his money, and did not know the silver from the copper coin. His eyes had a fixed, brilliant, and dazzling gaze; he could neither hear nor speak plainly, and there was great thirst; he caught at imaginary objects in the air, and seemed to have lost all knowledge of distance. His fingers were in constant motion: there was headache, but neither vomiting nor purging. He did not reach the hospital until nine hours had elapsed, and the symptoms were then much the same as those above described. He attempted to get out of bed with a reeling, drunken motion; his speech was thick and indistinct. The pupils were so strongly dilated that there was merely a ring of iris, and the eyes were quite insensible to light. The eyelids did not close when the hand was passed suddenly before them. He had evidently lost the power of vision, although he stared fixedly at objects as if he saw them. The nerves of common sensation were unaffected. When placed on his legs he could not stand. His pulse was 90, feeble and compressible; his mouth was in constant motion, as if he were eating something. His bladder was full of urine on admission. He continued in this state for two days, being occasionally conscious, when by a free evacuation of the bowels, some small seeds were passed : these were examined and identified as the seeds of belladonna. The boy gradually recovered, and left the hospital on the sixth day after his admission :—the progress of recovery was indicated by the state of the pupils, which had then only acquired their natural size and power of contraction. In three other cases which occurred at the same time, the berries having been baked in a pie, pains in the limbs, drowsiness, insensibility, and convulsions, were among the symptoms. In two instances of poisoning by the berries related by Dr. Moll, the symp-

toms bore a strong resemblance to those of delirium tremens, but among them were heat and dryness of the throat, loss of power of swallowing, incoherent speech, double vision, and strange spectral illusions, with occasional fits of wild and ungovernable laughter. On the following morning both these patients recovered as if from a dream; but they suffered for some time from languor, thirst and dryness of the throat: the pupils also continued dilated. (Casper's 'Wochenschrift,' Jan. 10, 1846, p. 26.) Two cases, showing the poisonous effects of the berries on children, are quoted in the 'Edinburgh Medical and Surgical Journal' (vol. 29, p. 452.)

The *root* of the belladonna, administered in the form of decoction as a clyster, has destroyed life. Four scruples of the root were employed, and the liquid, strained and reduced by evaporation to four ounces, was injected. After a slight stage of excitement, the patient, a female, æt. 27, fell into a state of complete coma; the countenance appeared swollen, and of a reddish-brown colour; the pupils were excessively dilated; the pulse was at first full and hard, then small; death took place in five hours. (Casper's 'Wochenschrift,' Feb. 8, 1845, p. 101.)

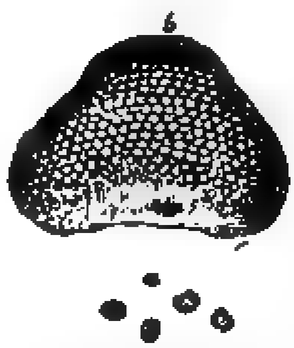
The *leaves* of belladonna have occasionally given rise to accidents. A young man swallowed an infusion of two drachms of the leaves. In about an hour he found great difficulty in swallowing, the salivary secretion was suppressed, and objects appeared to be in perpetual motion before him. He became delirious, attempted repeatedly to pass his urine but could not: and for an hour and a half he was in constant motion, although his gait was unsteady. The muscles of his face, jaws, and limbs were agitated by convulsive twitchings: the pupils were excessively dilated, and there were singular hallucinations. There was neither nausea, vomiting, nor purging. Emetics, injections, and bleeding were resorted to, and the next morning the patient awoke as if from a dream. ('Ann. d'Hyg.' Oct. 1847, p. 413.)

Fig. 81.

Small leaf of Belladonna, natural size.

Leaves of belladonna have been ignorantly supplied for ash-leaves, and half a wine-glassful of the decoction of the leaves produced on Dr. Garrod the usual symptoms of poisoning by this plant. His patient, who took half a pint, suffered severely. The chief symptoms were giddiness, difficulty in walking, dryness of the mouth and throat, and perversion of taste, indistinctness of vision, dilatation of the pupils, bloodshot eyes, difficult articulation, delirium, insensibility, and a scarlet redness of the skin of the face and neck, followed by a peeling off of the cuticle. The leaves of belladonna are peculiar in shape. The annexed illustration (Fig. 81) is from a photograph of a small leaf of the fresh plant. According to Mr. Luxton, 1,000 grains of leaves yield only five grains of atropia. (See 'Pharm. Journal,' 1855, p. 300.)

Fig. 82.



Seeds of Belladonna.
a. Natural size.
b. Magnified 30 diameters.

The *seeds* of belladonna are small, of a somewhat oval shape, and of a dark colour. Under a low magnifying power they have a honeycombed surface (Fig. 82). In henbane the surface of the seeds presents more irregular depressions, resembling those seen on certain corals or madrepores.

Two persons swallowed a small spoonful of the *extract* of belladonna by mistake for that of juniper. There was speedily indistinctness of vision, tottering gait, delirium, incoherency, hallucinations, and

dilatation of the pupils. In one there was great cerebral excitement. The apothecary to whom the extract was taken tasted it, and soon experienced symptoms which led to a suspicion of its real nature. Under treatment, the symptoms of poisoning disappeared in two days; but one of the patients died on the seventh day from disease. The physical and physiological properties of the extract indicated that it was belladonna; but the attempt to procure atropia from it entirely failed. A portion of the concentrated extract given to a dog, caused dilatation of the pupil in a quarter of an hour—an index of the rapidity with which the alkaloid atropia is absorbed into the blood. In a case of compound poisoning by extract of belladonna and tincture of opium, there was the violent excitement produced by belladonna, but the pupils were strongly contracted as in poisoning by opium. ('Med.Times and Gaz.' 1870, 1, 564.) A case occurred in February 1865, in which a lady suffered from severe symptoms of poisoning, and nearly lost her life, owing to an injection containing one drachm of the extract of belladonna, and one drachm of wine of opium having been administered to her. The pupils in this case were dilated, and the opium did not in any way counteract the effects of the belladonna.

The following case, which occurred in Nov. 1871, is remarkable for the fact that a woman recovered from a large dose of the extract. A nurse gave by mistake to a lady whom she was attending a belladonna liniment containing three drachms of the extract mixed with soap liniment. She vomited slightly. When seen by Mr. F. Keen he found her suffering from dryness of the throat, difficulty of swallowing, drowsiness, delirium, pupils dilated, fixed stare of the eyes, loss of power and difficulty of speech. Paralysis of the extremities came on, with great pain in the back. Emetics with brandy and cayenne pepper were employed with success. The woman recovered, but not until after five weeks from the time of swallowing the liniment.

Appearances.—The appearances observed in several cases of poisoning by the berries which proved fatal in London during the autumn of 1846, were as follows: the vessels of the brain were congested with liquid blood; the stomach and intestines were pale and flaccid; there were some red spots towards the cardiac end. In other fatal cases, of which the appearances have been reported, the vessels of the brain and its membranes were found distended with thick black blood. Red spots have also been observed around the throat and gullet, and congested patches of a dark purple colour on the coats of the stomach. In some instances the mucous membrane has been completely dyed by the juice of the berries. A boy, æt 5, after having eaten a quantity of the berries of the belladonna, went to bed, was very restless, vomited once, and died in convulsions about fifteen hours after having taken the poison. On inspection, the eyes were half-open, with an intense lustre; the pupils dilated; the mouth was spasmodically closed and the sphincter ani relaxed. The cerebral vessels were distended with dark-coloured blood; the substance of the brain, cerebellum, and medulla oblongata, presented numerous bloody points. In the throat and gullet there were several patches of redness. In the stomach there was some fluid, with three open berries; the mucous membrane was of a reddish-blue colour in various parts. (Case by Dr. Rosenberger, Canstatt's 'Jahresb.' 1844, v. 295.) For another case showing the appearances, see Horn's 'Vierteljahrsschrift,' 1866, 2, 159. A woman, æt. 66, swallowed a teaspoonful of belladonna liniment, and after suffering the usual symptoms died in sixteen hours. On inspection the lungs were found full of blood,—the right side of the heart contained but little black blood, and the left side was firmly contracted. The brain was slightly congested. The stomach and other organs presented nothing unusual. The inspection was made thirty-four hours after death, and the pupils were then dilated. ('Lancet,' 1870, vol. 2, p. 83.)

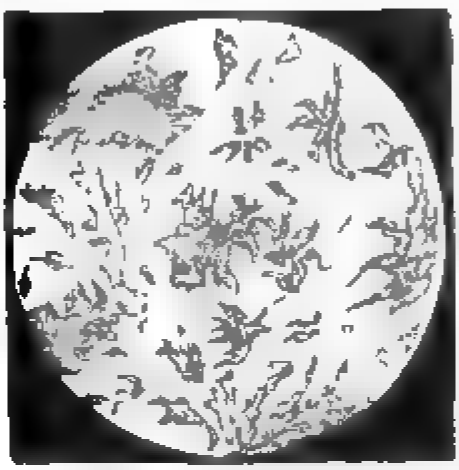
Analysis.—The indigestible nature of the leaves, fruit, and seeds will con-

monly lead to their detection in the matters vomited or passed by the bowels, or in the contents of the viscera after death. The seeds of belladonna are very small—they can, however, be distinguished by the microscope from the seeds of other poisonous plants. The colouring matter of the berry is of a deep purple hue: it is turned green by alkalies, and red by acids. The leaves would be known by their botanical characters, and a decoction or infusion of them, by the liquid causing dilatation of the pupil. Dr. Runge states that the urine, blood, or organic liquids containing this poison, applied to the eye of an animal, cause dilatation of the pupil. Orfila did not observe this effect in poisoning by belladonna (op. cit. ii. 267), and even if it occurred, he considered that it would be too vague a sign for diagnosis, as it may take place equally with henbane and stramonium.

ATROPIA.—Atropia is the name given to the alkaloidal principle of belladonna. This alkaloid is a powerful poison. In November 1850, Mr. Sells, of Guildford, forwarded to me for examination the stomach of a young man who had poisoned himself by taking *two grains* of atropia. He took the dose on going to bed. He was heard to snore heavily during the night, and was found dead about seven o'clock in the morning, lying on his right side, the surface livid, the limbs rigid and contracted, and with a little brown matter issuing from the mouth. The pupils were much dilated. The mucous membrane of the stomach presented a diffused redness, which might have arisen from some brandy which he had swallowed. No trace of the poison could be detected in the stomach or its contents. In the 'Association Medical Journal' (Sept. 16, 1853, p. 818) will be found the report of a case in which all the symptoms of poisoning by belladonna arose from the application of a weak solution of atropia and water to the conjunctiva. One-eighth of a grain injected into the skin for the relief of sciatica, produced the usual symptoms of poisoning. ('Pharm. Journal,' May 1862, p. 583.)

The criminal administration of atropia is a rare event in this country. A trial for murder by this alkaloid took place at the Manchester Lent Assizes, 1872 (*Reg.* v. *Steele*). The prisoner, who was a nurse in the workhouse, was charged with administering atropia to the senior surgeon, Mr. Harris, and thereby causing his death. The deceased was taken suddenly ill after his breakfast, and died under the usual symptoms of poisoning with atropia in about twelve hours. The poison was detected in the body by Mr. Calvert, and also in a liquid found in the room—a solution of atropia in spirit. Milk was the vehicle through which it was taken. The milk as sent from the kitchen contained nothing injurious, but that found in deceased's room was tasted by two of the nurses and both suffered from poisoning by atropia. The prisoner had access to this room, and it was alleged that she had a strong motive for this criminal act, but there was no direct proof to show that she put the poison into the milk, and she was acquitted.

Fig. 83.



Imperfect crystals of Sulphate of Atropia, magnified 30 diameters.

Analysis.—Atropia is a white crystalline substance, not very soluble in water, but easily dissolved by alcohol, ether, and diluted acids. It does not readily crystallize, but it forms crystallizable salts. The annexed illustration (fig. 83) shows the irregular crystalline form of the sulphate of atropia, as it is deposited from an alcoholic solution. Ammonia added to the solution of sulphate of atropia does not separate the alkaloid in distinct crystals. In this respect it differs from morphia and strychnia. When atropia is heated on platinum it melts, darkens in colour, and burns with a yellowish smoky flame.

Sulphuric, hydrochloric, and nitric acids dissolve it without any change of colour. Water added to the mixture of sulphuric acid produces no change: but a crystal of bichromate of potash produces a green colour from the formation of oxide of chromium. Tannic acid precipitates the alkaloid from its solutions: but the most effectual precipitant is the chloriodide of potassium and mercury, which throws down a dense white precipitate even in very diluted solutions. Atropia is also precipitated by chloride of gold, but, unlike strychnia, it is not precipitated by sulphocyanide of potassium or chromate of potash. It may be detected in, and separated from, organic liquids by the process of Stas. (See page 413.) According to Winckler atropia is precipitated most completely from all its solutions by the chloriodide of potassium and mercury (page 361). By the use of this precipitant he was able to determine the proportion of atropia contained in the powder of the dry leaves and root. In the leaves the alkaloid varied from 0·41 to 0·49 per cent. and in the root it amounted to 0·48 per cent. ('Pharm. Jour.' June 1872, p. 1029.)

A small quantity of a diluted solution of atropia applied to the eye produces dilatation of the pupil. This may be employed as a physiological test for detecting the presence of atropia in an extract made from the contents of the stomach, or of any organic liquid. The introduction of a portion into the cellular membrane of an animal, besides producing the ordinary symptoms of poisoning, causes dilatation of the pupil.

Indian Tobacco (Lobelia inflata).

The powdered leaves of Indian tobacco contain an acrid principle which is capable of producing poisonous effects on the brain and spinal marrow, attended with irritation of the stomach and bowels. When administered in doses of from ten to twenty grains, lobelia operates as an emetic; but in larger quantity it acts deleteriously. It would also appear that even ordinary medicinal doses affect some persons with great severity. There is an erroneous notion that this is a useful medicine and not a poison, although, like arsenic and opium, it may be either, according to the mode in which it is employed.

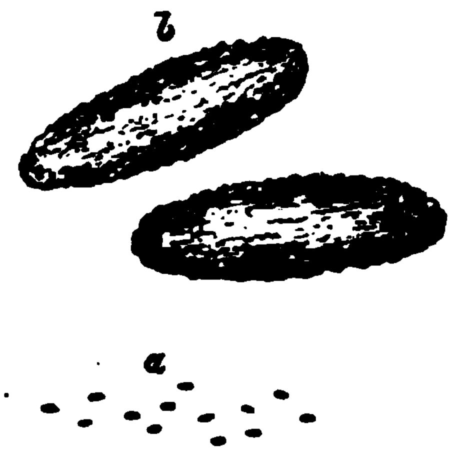
In one case a man lost his life by swallowing *one drachm* of the powdered *leaves*, prescribed by a quack. This person was seen by a medical practitioner soon after he had taken the poison: he was evidently suffering great pain, but he was quite unconscious; the pulse was small, and the pupils were strongly contracted and insensible to light. He had vomited the greater part of the poison. He suffered from spasmodic twitchings of the face, sank into a state of complete insensibility, and died in about thirty-six hours. On inspection, some fluid was found in the stomach, but none of the powder. The mucous membrane was intensely inflamed, and the vessels of the brain were strongly congested. ('Pharm. Times,' May 1, 1847, p. 182.) The *seeds* of lobelia are equally poisonous. In the 'Med. Times and Gazette,' Nov. 26, 1853, p. 568, two cases are reported in which the seeds proved fatal. In one, the mucous membrane of the stomach was highly inflamed. Another case is referred to in the same journal, March 12, 1853, p. 270.

There have been many inquests and trials for manslaughter in this country as the result of the improper administration of the powdered *leaves* of the *Lobelia inflata* by ignorant quacks, calling themselves medical botanists and dealers in vegetable medicines. The medical evidence given on these trials has proved that in large doses lobelia is a most noxious drug. (See 'Medical Gazette,' vol. 44, pp. 383 and 433; vol. 46, p. 384; 'Lancet,' March 5, 1853, p. 237; 'Pharm. Jour.' Aug. 1851, p. 87; and for some remarks on the action of the poison see a paper by Mr. Curtis and Dr. Pearson, 'Med. Gaz.' 1850, vol. 46, p. 285; also Pereira, 'Mat. Medica,' vol. 2, part 2, p. 12.) The impostors who profit by the prescription and sale of this drug among the ignorant poor, maintain the doctrine that it cannot kill, and never has been

known to destroy life! In July 1856, one of these quacks was convicted on a charge of manslaughter for killing a woman with overdoses of lobelia. Severe pain, followed by loss of consciousness and congestion of the brain, were the chief symptoms preceding death in this case. The admission that, in proper doses, it was a useful remedy in spasmodic asthma, was of no avail on this occasion. The man was sentenced to three months' imprisonment. (*Reg.* v. *Boyden* or *Jackson*, Lincoln Summer Assizes, 1856.) A man named *Riley Drake* was convicted in the United States of having caused the death of a woman by administering lobelia in improper doses. (Wharton and Stille's 'Med. Jur.' p. 522.)

Analysis.—Lobelia is seen in the form of a greenish-coloured powder (fragments of leaves). This powder acquires a reddish-brown colour from strong nitric acid, and is blackened by concentrated sulphuric acid. Iodine water has no effect upon the infusion. The proto- and per-sulphate of iron produce with it a dark-green colour, the per-sulphate very rapidly. The leaves and seeds contain a resinoid substance called *Lobelin*, which has the smell and taste of the plant. It acts as a powerful emetic in doses of from one-half to one grain. The leaves of lobelia are generally seen in fragments which do not readily admit of identification by the microscope. The *seeds* are very small, of a lengthened oval shape, reticulated on the surface with projecting hairs or fibres, and of a light brown colour (fig. 84). The discovery of them among the fragments of leaves would furnish a sufficient proof of the presence of lobelia.

Fig. 84.



Seeds of Lobelia.
a. Natural size.
b. Magnified 70 diameters.

Foxglove (Digitalis purpurea).

Purple foxglove is a well-known hedge-plant, growing abundantly in the southern districts of England. All parts of the plant—the seeds, leaves, and root—are poisonous, owing to the presence of the poisonous principle, *digitaline*. The leaves, whether in the form of powder, infusion, extract, or tincture, exert an action on the brain and spinal marrow, as well as on the stomach and bowels. They retain their noxious properties when dried.

Symptoms and Effects.—Cases of poisoning by foxglove are not very numerous. One was the subject of a criminal trial at the Old Bailey, in Oct. 1826. A quack was indicted for the manslaughter of a boy under the following circumstances:—He prescribed for a trivial complaint six ounces of a strong decoction of the *leaves*. The boy was soon attacked with vomiting, purging, and severe pain in the abdomen. After some time he became lethargic, and slept for several hours; in the night he was seized with convulsions. The pupils were dilated and insensible, the pulse was slow, small, and irregular; coma followed, and the boy died twenty-two hours after taking the poison. On *inspection* the membranes of the brain were found much injected, and the mucous lining of the stomach was partially inflamed. The prisoner was acquitted of the charge, because he had only given his fatal advice on the application of the friends of the deceased! ('Ed. Med. and Surg. Jour.' vol. 27, p. 233.) A young man swallowed a strong *decoction* of foxglove by mistake for purgative medicine. He was soon seized with vomiting, pain in the abdomen, and purging. In the afternoon he fell asleep. At midnight he awoke, was attacked with violent vomiting, colic, convulsions, and the pupils were dilated and insensible to light; his pulse was slow and irregular. He died twenty-two hours after taking the poison. (Wibmer, op. cit. *Digitalis.*) A few grains of the powdered leaves have been known to produce giddiness, languor, dimness

of sight, and other nervous symptoms. A drachm, however, has been taken without causing death; but in this instance it produced the most violent vomiting. As an indication of the singular effect of this poison on the nerves of sensation, it may be stated that a coal-fire appeared to the patient to have a blue colour. A common effect of this poison is to produce great depression of the heart's action. A woman made an infusion of digitalis, and swallowed it by mistake. The symptoms which followed were vomiting, paleness of the face, coldness of the skin, prostration, muscular feebleness, a persistent feeling of drunkenness, headache, giddiness, confusion of sight, dilatation of the pupils, and loss of sensibility. The vomiting was constant, and aggravated by anything that was taken. There was constipation of the bowels, with suppression of urine. There was thirst with pains in the abdomen increased by pressure, and great restlessness at night. At first the pulse was 52. On the fourth day it was 41 to 42. On the fifth day it was 58, less irregular, and the symptoms had abated. During the night she got up, and on returning to her bed suddenly fainted, and died. Nothing could restore her from the attack. This was probably the effect of the poison. A person labouring under symptoms of poisoning by digitalis should always be kept in the recumbent posture. (Case by Dr. Mazel, 'Ed. Monthly Jour.' 1864, p. 169.)

Analysis.—When foxglove has been taken in substance, *i.e.* in the form of seeds or leaves, or any portion of these has been swallowed in a decoction or infusion, fragments may be found in the stomach and bowels. In reference to the infusion, decoction, tincture, or extract, except there be sufficient to allow of the separation of digitaline, there is no chemical process known by which the poison may be recognized. If any fragments of leaves or seeds are found in the contents of the stomach or in food, they may be identified by the aid

Fig. 85.

Leaves of Foxglove.

Fig. 86.

Seeds of Foxglove.
a. Natural size.
b. Magnified 30 diameters.

of the microscope. The annexed illustration (fig. 85), taken from the living plant by photography, represents a small leaf and a portion of a larger leaf of this plant.

It is calculated that digitaline constitutes only one per cent. of the dried leaves. In reference to the *seeds* of foxglove, they are of a reddish-brown colour, remarkably small, oblong, and somewhat angular in shape. They have peculiar markings (fig. 86.) By the aid of the microscope they may be easily distinguished from the seeds of hyoscyamus, datura, belladonna, and most other poisonous plants.

DIGITALINE.—Digitaline is the active principle of foxglove: its physiological properties have been fully investigated by M. Homolle ('Journal de Pharmacie,' Janvier 1845–57; also, Bouchardat, 'Ann. de Thérapeutique,' 1864, p. 155). The samples which I have examined have had a pale fawn colour, and no crystalline character. I have found it impossible to crystallize it either by the use of alcohol, ether, or chloroform. M. Nativelle has recently obtained it by the aid of boiling alcohol at 90 per cent. in fine white and shining needles ('Pharm. Journ.' 1872, April 27, p. 865). Alcohol is its best solvent. Boiling water takes it up in small quantity, acquiring a tea-like odour: its solutions are intensely bitter. It is a neutral vegetable principle, having neither alkaline nor acid reaction. In solution it is precipitated by tannic acid, but not by the chloriodide of potassium and mercury; and by this property it may be distinguished from the true vegetable alkaloids. It forms no salts with acids. When heated in a tube, it melts and is decomposed: it evolves an acid, and not an ammoniacal vapour. Strong nitric acid dissolves it, and gives to it a deep orange-red colour unlike that of morphia or brucia. This acid solution speedily acquires a pale yellow colour on standing. Iodic acid is unchanged by it. Hydrochloric acid dissolves it, and when gently heated the solution becomes green. Strong sulphuric acid gives to it a brown colour, and after exposure for some time or by a gentle heat this colour changes to a purple black. If the sulphuric acid solution is diluted, the liquid immediately assumes a dingy green colour. Diluted sulphuric acid heated with the powder gives a reddish-black colour. M. Grandeau has suggested an addition to this test. If the digitaline has been previously dissolved and the liquid evaporated, sulphuric acid imparts a rose colour to small quantities, or a reddish-brown or even brown colour when the digitaline is in rather large quantity. If the digitaline, moistened with sulphuric acid, is exposed to the vapour of bromine, it immediately assumes a violet colour. This peculiar colour is observed even with the faintest trace of the principle, and it is regarded by him as characteristic. Seventeen of the alkaloids and principles thus tested did not acquire a violet colour. ('Chemical News,' July 16, 1864, p. 26.) According to M. Grandeau, digitaline readily admits of separation by dialysis from organic liquids. MM. Tardieu and Roussin have not found this method so successful in practice as these experiments on pure digitaline would appear to indicate. ('Ann. d'Hygiène,' 1864, p. 80.)

M. Homolle extracted from foxglove, by means of alcohol, three substances: an acrid matter soluble in ether, which produced on himself violent vomiting and fearful head-symptoms leading almost to the destruction of life; a highly concentrated bitter principle; and digitaline. The latter alone was proved upon hospital patients to have the power of decreasing the action of the heart, lowering the pulse, and increasing the quantity of urine. ('Pharmaceutical Journal,' Oct. 1861, p. 245.) Pure digitaline itself operates powerfully on man and animals in very small doses, and it must be regarded as a deadly poison. The 1-16th of a grain, which is considered to be equal to eight grains of the well-prepared powder of the dried leaves, is sufficient to cause symptoms of poisoning. Doses of from 1-11th to 1-32nd part of a grain have lowered the pulse and caused nausea, vomiting, griping, purging, and an increased secretion of urine. (Pereira, 'Mat. Med.' vol. 2, p. 528.) Doses of from one-quarter to one-half of a grain would probably prove fatal to life. M. Homolle found in experiments on himself that small doses of digitaline taken at intervals lowered the pulse to about one-fourth or one-fifth of the normal standard: thus in himself it fell 17 in one minute, which represents a fourth of the normal pulsations. In doses of from 1-15th to 1-30th of a grain in twenty-four hours, digitaline slackened the circulation. In doses above 1-15th of a grain, it produced on adults emetic and purgative effects, sometimes suddenly,

at others slowly and gradually. In doses of from one to two grains, unless speedily thrown off by vomiting, it killed dogs in a few hours. (Orfila, 'Toxicologie,' vol. 2, p. 350. See also a paper by Drs. Stevenson and Fagge, 'Guy's Hos. Rep.' 1866, p. 37.)

Digitaline has acquired some notoriety by reason of the trial of *Dr. De la Pommerais*, at Paris, in May 1864, for the murder of a woman named Pauw. The deceased, who was about forty years of age, and in the enjoyment of good health, was suddenly seized with violent vomiting, and, after an illness of about twenty-four hours, died on the 17th November 1863. The prisoner had just renewed his intimacy with her at the time of the occurrence of this fatal illness; and, after a long interval of absence, he had induced her to insure her life in various insurance offices for an enormous sum of money, quite disproportioned to her circumstances. Immediately after her death he put in a claim for these large insurances. The body of the deceased was exhumed and inspected for the first time on the 30th of November, thirteen days after death. The viscera throughout were healthy; they presented no unusual appearance, and revealed no natural cause of sudden death. The stomach and bowels, which were well preserved, bore no marks of the action of poison; and, on a chemical analysis, no poison of any kind could be detected in these organs by MM. Tardieu and Roussin. The symptoms, during the illness, owing to there being no suspicion of poisoning, were not accurately observed. Repeated vomiting, with great depression and exhaustion, seem to have been the most prominent. Failing to detect any poison by chemistry and the microscope, the experts adopted the physiological test of administering prepared alcoholic and aqueous extracts of the stomach and intestines to animals. An attempt made to separate the active principle and remove the organic matter by dialysis, did not yield satisfactory results. ('Annales d'Hygiène,' 1864, 2, 105.) Seventy-five grains of the mixed extracts above mentioned were introduced into the cellular membrane of the thigh of a dog. The animal vomited twice; and in four hours the pulsations of the heart sank from 102 to 86: its action was irregular and intermittent, and the respiration was deep and painful. There were no narcotic symptoms; on the next day, the dog was better, and it completely recovered. Sixty grains of these extracts in water, administered to a rabbit by means of a funnel, caused death in a few minutes, probably from syncope (or asphyxia?).

Another branch of physiological evidence unexpectedly presented itself. The deceased, during her fatal illness, had vomited on the floor of her room. An alcoholic extract was made of the scrapings of the floor and of the substances deposited between the planks. No mineral poison was found in it. Seventy-five grains of this extract were introduced into the cellular membrane of the thigh of a dog. The animal suffered from vomiting and depression of the action of the heart, and died in about twenty-two hours. There was no coma or insensibility at any time. Thirty-one grains of the same extract diffused in water were administered to a rabbit by means of a funnel. In less than three hours after the injection the animal died, having suffered from irregular and depressed action of the heart. Sixty grains of an alcoholic extract from the scrapings of the floor, said to be free from vomited matters, had no effect upon an animal.

These two extracts of the floor had different chemical properties. The first, containing, as it was believed, a portion of the vomited matters, amounted to half an ounce. It was of a brown colour, had a rancid oily odour, and a bitter taste. Its solution was precipitated by tannic acid: it was coloured purple-red by sulphuric, and green by hydrochloric acid. The second was coloured, had an oily aspect, but no bitterness. It was not precipitated by tannic acid, and was feebly coloured by the sulphuric and hydrochloric acids; the results being different from those obtained with the first extract. It was objected to

any inferences from the properties of these extracts, that deceased's room had been formerly occupied by a photographic artist: but it is expressly stated that no noxious mineral substances, such as are used in photography, were found in them. No attempt was made to procure digitaline from the extracts: the presence of this principle was a matter of inference, from the extracts produced: and the reason assigned for the extract derived from the stomach and bowels of deceased having no fatal effect upon animals, was that the quantity of the principle left in the body at the time of death was too small.

MM. Tardieu and Roussin deposed at the trial that the deceased had died from a vegetable poison which produces no marked change in the body, which cannot be revealed by chemical analysis, but only by its noxious effects on animals. The effects on animals were in this case similar to those caused by digitaline, and without positively affirming that the deceased woman, Pauw, had died from this poison, there was the strongest presumption that she fell a victim to it. The deceased was quite well the day before her death, and the post-mortem examination of the body proved the absence of any natural cause to account for this sudden death.

In reference to the accused, it was proved that he had in his possession a large number of poisons of a deadly kind, including digitaline; that he had at three different times purchased as much as fifty-two grains of this poison, of which much had been used, and that those quantities were inconsistent with any reasonable medical requirements. As the prisoner was a homœopathic practitioner, the purchase and actual use of such large quantities of so potent a drug were quite inexplicable on any theory consistent with his innocence. On the other hand, the case was equally against him in its moral aspects; it was clearly established that, by reason of the large insurances effected on her life, he had a strong motive in the death of the woman, that a long cessation of their intimacy had taken place by reason of his marriage with another person, that he had suddenly and without any reasonable grounds renewed his intimacy with the deceased, and the date of her fatal illness was in accordance with these visits thus renewed. In short, Dr. De la Pommerais had the motive, means, and opportunity of destroying the life of this woman by poison, and no theory consistent with his innocence could be suggested, by those who defended him, to explain satisfactorily the mass of moral and medical circumstances which were clearly proved against him. Further, as with some other criminals, he over-acted his part, and by forged letters and correspondence had shown that he had fully anticipated the sudden death of the woman Pauw, and the explanations that might be required of him in order to account for this event. Apart from any questions respecting the speculative character of the medical evidence, there were circumstances proved in this case which were inconsistent with any theory of the innocence of the accused. The jury found him guilty of murder, and he was subsequently executed.

THORNAPPLE (DATURA STRAMONIUM).

All parts of this plant are poisonous; but the *seeds* and *fruit* are considered to be the most noxious.

Symptoms.—The usual effects produced by this poison will be understood from the following cases. A woman, æt. 36, took two teacupfuls of infusion of stramonium leaves by mistake for senna tea. In about ten minutes she was seized with giddiness, dimness of sight, and fainting. In two hours she was quite insensible; the pupils were fixed and dilated, all the muscles of the body convulsed, the countenance flushed, and the pulse was full and slow. The stomach-pump was applied, and in the course of a few hours she recovered,—suffering, however, from indistinctness of vision and vertigo. ('Med. Gaz.' vol. 8, p. 605.) The *seeds* of this plant are highly poisonous. A boy, æt. 5, ate some seeds, with a portion of the plant. Soon afterwards it was observed that his

face was flushed, and that he staggered as if intoxicated. He vomited and threw up about thirty seeds. His skin was hot and red, the countenance had a wild and staring expression, the pupils were nearly fully dilated and insensible to light. The child was restless, in a state of raging delirium, and biting with fury at those who attempted to restrain him. He was unable to stand, and in a state resembling St. Vitus's dance. The pulse could not be counted. The breathing was hurried and gasping. He was incessantly talking, but without articulating distinctly, and he appeared to be driving away from him imaginary objects. Emetics produced the vomiting of more seeds, and in an hour he began to articulate. He slept restlessly for two hours. Some seeds were passed in the evacuations from the bowels. In four hours the symptoms had abated, and the boy gradually improved. The pupils did not recover their natural state until after three days. ('New York Journal of Medicine,' 1856; and 'Brit. and For. Med. Rev.' 1857, 19, 497.)

In the 'American Journal of Medical Science,' April 1864, p. 552, Dr. Turner describes five cases of poisoning by the seeds, in children under ten years of age. They had eaten them in the scarcely ripe state, when they are not very bitter. In one hour and a half two of the children were found to be fully under the influence of the poison. They were lying on their backs, eyes bright, pupils widely dilated and insensible to light; conjunctivæ injected, face deeply suffused and of a dark crimson colour; difficulty of breathing, inability to articulate, and in a state of complete insensibility, broken occasionally by a paroxysm during which they would utter some indistinct sounds and throw their hands about, as if trying to ward off some threatening evil. They then fell into a comatose state, but were easily roused into a state of violent excitement: they grasped at imaginary objects; there was picking at the bed-clothes, with paroxysms of excessive laughter. They had no proper control over their limbs, walked with a staggering gait, and fell to the ground as if intoxicated or in a state of complete exhaustion. They recovered under treatment in about twenty-four hours. (See also other cases by Dr. Lee, in the same journal, Jan. 7, 1862, p. 54.)

Death may take place although the whole of the seeds are ejected. This happened in a case reported by Mr. Duffin—that of his own child, æt. 2, who swallowed about one hundred seeds of stramonium, weighing sixteen grains. The usual symptoms were manifested in an hour, and the child died in twenty-four hours, although twenty seeds had been ejected by vomiting and eighty by purging. ('Med. Gaz.' vol. 15, p. 194.) Sufficient daturia to destroy life had been absorbed from the entire seeds and carried into the blood. In a case which became the subject of a trial at Osnabrück, a woman administered to her mother a decoction of the bruised *seeds* of the thornapple, of which it was supposed there were about 125. She very soon became delirious, threw her arms about, and spoke incoherently: she died in seven hours. (Henke, 'Zeitschrift der S. A.' 1837, i. H.) The seeds retain their properties notwithstanding exposure to heat: thus the smoking of stramonium-seeds is attended with danger. In the return of the Registrar-General for April 1856, there is the record of one death from this cause.

One of the methods of poisoning adopted by the Hindoos, not so much with the intention of destroying life as of facilitating the perpetration of robbery, consists in administering to persons either the powdered seeds, or a strong decoction of them, in curry, or some other highly-flavoured article of food. Delirium and insensibility soon follow, and sometimes death is the result; but no suspicion of the real cause appears to be excited.

Dr. Brown, of Lahore, states that out of ninety-two of these cases of poisoning no fewer than twenty-one proved fatal, but it is probable that many which result in death are never known, while those who survive would naturally complain of any injury that might have been done to them while insensible. He observes

that the drug has a bitter taste, which it generally imparts to the food with which it is mixed, and which is sometimes recognized when it is eaten. The symptoms usually occur in about ten minutes after the poison has been taken, although they may be delayed from half an hour to an hour. There is at first dryness in the throat, attended with a feeling of faintness, headache, and giddiness, and the person has difficulty in walking straight, and appears as if intoxicated, while at the same time he is very restless. The pupils of the eyes, if examined, are found to be dilated, and he will sometimes complain of indistinctness of vision, or drowsiness and he almost always falls asleep. The sleep may either increase to complete insensibility with dilated pupils, a flushed face, and muttering delirium, or the patient may awake and then become delirious. The delirium is characterized by great restlessness, the person affected frequently moving about, and there is a tendency to go naked and to pick at various objects. The pulse is generally slow, the pupils are dilated, and there is great thirst. After a time the patient becomes again insensible and is greatly exhausted: sometimes convulsions occur, with low muttering delirium, and at length he dies. If, as it more frequently happens, he recovers, the insensibility persists for a day or more, and the patient remains occasionally in an idiotic state, able to speak, but not to understand for some time longer, and he has no recollection of what has occurred after the poisonous meal. Sometimes vomiting is an early symptom, although this is rare. ('Description of Poisons in the Punjab,' 1863, p. 57.)

Dr. Chevers has given a very complete account of the Hindoo system of poisoning by *dhatoora*. ('Med. Jur.' for India, 1856, pp. 121, 549, 591.) It appears that the *Datura fastuosa* and *alba* are the principal sources of the poison in India. The Thugs employed this poison with the object of rendering their intended victims helpless. As it is administered by skilled professional poisoners in India, it causes a profound lethargy resembling coma, with dilated pupils. The symptoms may continue for two days, and yet recovery take place. He also states that the cases rarely prove fatal. Out of fifty-one instances of poisoning by dhatoora, at the Bombay hospital in one year, recorded by Dr. Giraud, one only proved fatal, and four presented very alarming symptoms. Dr. Chevers notices the early occurrence of insensibility. A man drank two mouthfuls of a poisoned liquid, complained of a bitter taste, and fell down insensible within forty yards of the spot where he had drunk the liquid, and did not recover his senses until the third day after. (Op. cit. p. 137.) In these cases, probably the seeds are given in a large dose, either in solution or in very fine powder. The first stage of poisoning is commonly marked by delirium, the patient is restless and wanders about as if in search of something, but from giddiness or great muscular weakness he is soon unable to walk or even to stand; he talks incoherently, laughs wildly, moves about as if to avoid spectra, and picks or catches incessantly at real or imaginary objects. He appears as if drawing out imaginary threads from the ends of his fingers, and his antics are of the most varied and ludicrous kind. The pupils are invariably dilated, and the spectra are illusions depending on disordered vision. Distant objects appear near to him, and near objects as if highly magnified: he will attempt to grasp a distant object as if it were close at hand, and will start back on a person approaching, as if he thought the person was quite near to him. In the second stage of poisoning, there is either great drowsiness or complete stupor, sometimes passing into utter insensibility, with stertorous breathing. The third stage of final delirium is similar to the first. (Op. cit. p. 593.) I am indebted to Dr. Irving, of Allahabad, for some additional information respecting the employment of datura by the professional poisoners of India. ('Cases of Food-Poisoning,' &c., 1864.) The effects are generally produced within a quarter of an hour, and those who have taken the poisoned food have had little or no recollection of anything that occurred afterwards. An extract of datura is probably used as

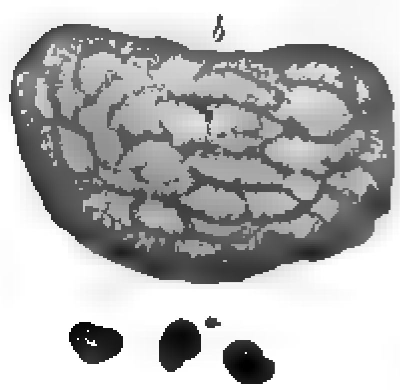
one of the methods of 'hocussing' persons by thieves in this country. The dilatation of the pupil, with the peculiar train of symptoms above described, would distinguish this state from ordinary intoxication. The bitter taste of the liquid might excite suspicion; but if the person is already partially intoxicated, he may be incapable of making any observation of this kind.

Appearances.—In a well-marked case of poisoning by stramonium-seeds, in which death took place in less than eight hours, Mr. Allan found the following appearances: great congestion of the vessels of the brain and its membranes, the brain firm and highly injected, choroid plexus turgid, ventricles containing serum, substance of the lungs congested, and the heart flaccid. The stomach contained about four ounces of digested food mixed with eighty-nine seeds of stramonium. There were two patches of extravasation in the mucous coat—one on the larger curvature, and the other near the pylorus. Many seeds and fragments were also found in the intestines. ('Lancet,' Sept. 18, 1847, p. 298.) In the Osnabrück case there were marks of diffused inflammation about the cardiac end of the stomach.

Dr. Irving describes the appearances met with in the body of one of the professional Indian poisoners, Bassawur Singh, who, in order to lull suspicion, partook of the poisoned food himself. His intended victims became insensible; he robbed them and left them to their fate. After a time they recovered their senses, and gave information at the police-station. The poisoner was found under a tree, about a mile from the place, quite insensible. Remedies were unsuccessfully used, and he died shortly after being apprehended. On his person was found all the stolen property, besides a quantity of datura seeds. The following were the post-mortem appearances: The pupils were widely dilated: the body was covered with dust, as if it had been rolled on the ground. The fingers of both hands were firmly clenched. There was great venous congestion of the brain and membranes: slight effusion of bloody serum under the membranes, chiefly on the right hemisphere. About an ounce of dark fluid blood was found at the base of the skull. The bloody points on a section of the brain were numerous. The ventricles contained a considerable quantity of serum. The choroid plexus was unusually full of blood. In the stomach there was a quantity of food, partly digested, in which were found seeds of datura as well as seeds of the *Solanum melongena*, which in form they somewhat resembled. ('Cases of Food-Poisoning,' &c., 1864. 'Indian Annals of Medical Science,' No. 17.)

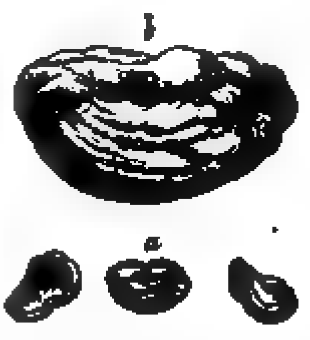
Analysis.—The *seeds* of stramonium, from which accidents have most frequently occurred, are flattened, kidney-shaped, but half oval, rough, and of a dark-brown or black colour (fig. 87). The seeds are liable to be mistaken for those of capsicum. Dr. Brown thus describes the difference:—'The datura seeds present dots on their exterior, which on a microscopical examination are seen to be composed of convoluted ridges surrounding spaces. On the capsicum seed these convoluted ridges run nearly parallel to each other, and are joined at right angles by shorter ridges, so that most of the spaces are of an oblong form, and are as lines curving round the seed: but in datura, the ridges are more convoluted and irregular, joining at acute angles and circumscribing

Fig. 87.



Seeds of Datura stramonium.
a. Natural size.
b. Magnified 20 diameters.

Fig. 88.



Seeds of Datura alba (India).
a. Natural size.
b. Slightly magnified by a lens.

irregular spaces.' ('Poisons of the Punjab,' 1869, p. 67.) Of the dry datura stramonium, there are about eight seeds to a grain. They are of an oblong kidney-shape, and of a dark-brown or black colour. The seeds of the datura fastuosa, received from Dr. Brown, of Lahore, are so similar in size and general appearance, that a separate illustration of them is quite unnecessary. The seeds of datura alba, also received from Dr. Brown, are larger, flatter, and much lighter-coloured, but have similar microscopical characters. These are the seeds which are chiefly used by the Thugs and the poisoning robbers of India.

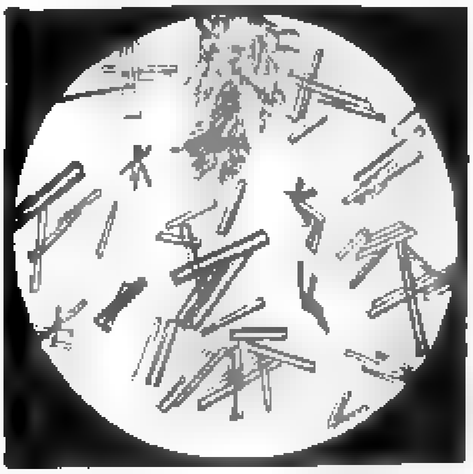
The *leaves* of the common datura stramonium are well characterized by their peculiar shape. In the annexed illustration (fig. 89) is represented a small leaf of the datura stramonium from a young plant. In the full-grown plant the leaves retain the same characters, but are much larger. It has been engraved from a photographic impression of a fresh leaf of the plant, and shows by dark lines the venation of the leaf.

DATURIA.—The poisonous properties of thornapple are owing to the presence of an alkaloid, *daturia*, which forms about one per cent. of the dried vegetable. For a comparison of its properties with those of Atropia and Hyoscyamia, which it resembles, see Bourchardat, 'Ann. de Thérapeutique,' 1864, p. 24. This alkaloid crystallizes in long colourless prisms or needles; it has a bitter taste, somewhat acrid, and slightly resembling that of tobacco (fig. 90). It is poisonous. The eighth of a grain killed a sparrow in three hours. When placed on the eye, or introduced into the cellular membrane of an animal, it is observed, like atropia, to cause dilatation of the pupil. When heated in a tube it is decomposed, and ammonia is evolved, as with other alkaloids. It is soluble in water, and the solution has an alkaline reaction. It is precipitated by tannic acid and by the chloriodide of potassium and mercury. Nitric and hydrochloric acids dissolve it, without producing any change of colour. Sulphuric acid produces a pale rose-red colour with the crystals, which becomes paler when the acid mixture is diluted with water.

Fig. 89.

Small leaf of Stramonium, from a photograph: natural size.

Fig. 90.



Crystals of Daturia, magnified 30 diameters.

LABURNUM (CYTISIS LABURNUM).

Symptoms and Effects.—The *bark* and *seeds* of the common LABURNUM contain an active poison called *Cytisine.* A case of poisoning by the *bark*, which was the subject of a trial at Inverness, has been reported by Sir R. Christison. ('Ed. Med. and S. J.' Oct. 1843.) A youth, with the intention of merely producing vomiting in one of his fellow-servants, a young woman, put some dry laburnum-bark into the broth which was being prepared for their dinner. The cook, who remarked a 'strong peculiar taste' in the broth, soon became very ill, and in five minutes was attacked with violent vomiting. The

account of the symptoms is imperfect, for the cause of them was not even suspected until six months afterwards. The vomiting continued thirty-six hours; was accompanied by shivering, pain in the abdomen, especially in the stomach, and great feebleness, with severe purging. These symptoms continued, more or less, for a period of eight months; and the woman fell off in flesh and strength. At this time she was seen by a physician, who had been called on by the law authorities to investigate the case. She was then suffering from gastro-intestinal irritation, vomiting after food, pain in the abdomen, increased by pressure, purging, tenesmus and bloody evacuations, with other serious symptoms. The medical opinion was that she was then in a highly dangerous state. The woman did not eventually recover until the following April. There was no doubt, from the investigation made by Dr. Ross and Sir R. Christison, that her protracted illness was really due to the noxious effects of laburnum-bark. These powerful effects of the bark were observed in a case which occurred to Mr. Tinley, of Whitby. A girl, æt. 18, idly and unthinkingly put a small portion of a laburnum-branch into her mouth, carrying it for some hours, and chewing it. It was described as of the thickness of the little finger, and two or three inches long. There were some yellow flowers with it, but she was not aware that she had swallowed any. In about half an hour she felt unwell, but she was not seen by Mr. Tinley until the day following. The symptoms then were great pain in the stomach, nausea and retching, but no vomiting; pulse 100, tongue white, great thirst, anxiety and pallor of countenance, dilated pupils, sense of fainting, even while lying down, and great exhaustion. There was no purging. Under treatment these symptoms disappeared, and the girl recovered in about a fortnight. ('Lancet,' 1870, 182.)

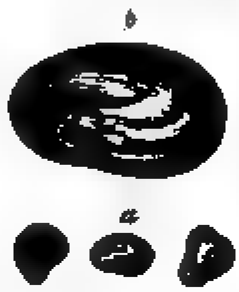
In reference to poisoning by the *seeds* of laburnum, there are but few instances recorded. Dr. Traill has described two cases, and Mr. Rake, a former pupil, has communicated to me a case of poisoning by the pods and seeds, which occurred in September 1851. Two children, the one aged two and the other three years, had been playing together, and on returning home they appeared unwell, and soon afterwards vomited. They had been seen with laburnum-pods in their hands, and some seeds with portions of the pods were mixed with the vomited matter. Both children were pale and exhausted, with a slow and somewhat feeble pulse. The pupils were natural. An emetic was given, but no more seeds were ejected: the pulse increased in volume and frequency, and the next day the children had recovered their usual health. In October 1856, twelve children, at Otley, in Yorkshire, were attacked with rigidity of the limbs and other symptoms of poisoning in consequence of having swallowed these seeds. They recovered under the use of emetics. ('Lancet,' Nov. 1, 1856, p. 497.)

In September 1862, two boys swallowed a quantity of laburnum-seeds in a cake. In about three-quarters of an hour one was seized with vomiting and purging,—pulse weak and frequent,—severe rigors,—muscular twitchings in the face and neck, and great epigastric pain. The pupils were dilated, but there was no headache. Many seeds were vomited. There was a great disposition to sleep, and coldness of the skin. Under treatment they recovered. ('Pharm. Journal,' Oct. 1862, p. 185.) In September 1863, a girl, æt 9, died at Worcester in consequence of having eaten a few of the seeds. A boy, æt. 4, ate about ten of the seeds. In half an hour he began to vomit, the vomited matter consisting of food and thick mucus. He afterwards became drowsy, and was seized with convulsions, shaking violently and drawing up his limbs at intervals. Although drowsy, he was easily roused, but soon dozed off again. Both pupils were largely dilated, pulse small, 85, surface, especially of the limbs, cold. He fell into a calm sleep, and the next day he was well. ('Lancet,' 1871, 2, 396.) The late Mr. Barber, of Stamford, communicated to me, in

June 1848, the particulars of a case which shows that even the *flowers* of this plant are highly noxious. A child between three and four years of age ate twelve laburnum-flowers, and in about fifteen minutes it complained of sickness and severe pain in the stomach. The child vomited a quantity of mucus mixed with the yellow petals of the laburnum. An emetic was given: this cleared the stomach, and the child recovered. There was no purging. ('Guy's Hosp. Reports,' Oct. 1850, p. 219.) A case in which a child suffered from symptoms of a nervous kind by reason of its having eaten laburnum-flowers, is described by Mr. North in the 'Medical and Physical Journal,' vol. 62, p. 86.

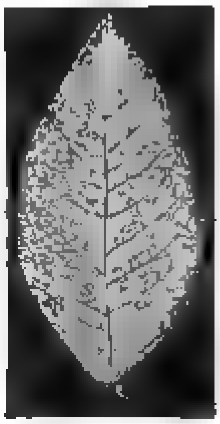
Analysis.—The poisonous principle of the laburnum is called *Cytisine.* It is difficult of separation, and at present has no well-defined chemical properties whereby it may be identified. Hence, when administered in powder, infusion, or decoction, there are no chemical processes known by which the poison may be detected. A decoction of the bark forms a clear light brown liquid, having an acid reaction. It strikes a dark olive-green colour with a persalt of iron. Nitric acid renders it lighter. Acetate of lead precipitates it, but the precipitate has none of the properties of meconate of lead. The *leaves* of the laburnum are well known. An illustration of a leaf of its natural size, which is copied from a photograph, is annexed (fig. 92). The *seeds* are somewhat kidney-shaped, slightly hooked at the hilum. They shrink in drying, become dark-coloured, and present irregular depressions on the surface. They have no markings, and are thus easily distinguished from most other poisonous seeds. They are larger than those of datura stramonium (fig. 91).

Fig. 91.



Seeds of Laburnum. *a.* Natural size. *b.* Slightly magnified by a lens.

Fig. 92.



Leaf of Laburnum, natural size.

Cytisine is said to be the poison contained in an insect powder, which is known by the name of Australian or Persian Insect Powder.

YEW (TAXUS BACCATA).

The yew appears to be a cerebro-spinal poison. The symptoms produced by the *leaves* and *berries* are uniform in character: convulsions, insensibility, coma, dilated pupils, paleness of the countenance, small pulse, and cold extremities, are the most prominent. Vomiting and purging are also observed among the symptoms. In two cases, the subject of one—a girl about five years of age—died in a comatose state in four hours after she had eaten the *berries*, and the other a boy, æt. 4 years, died nineteen days after taking the berries, obviously from severe inflammation of the bowels. The immediate symptoms in the boy were vomiting, purging, coma, convulsions, dilated pupils, hurried respiration, a small pulse, and a cold skin. (See 'Prov. Jour.' Nov. 29, 1848, p. 662, and Dec. 27, p. 708.)

The *leaves* and *berries* of this tree have been long known to be poisonous to cattle, causing death in a few hours, sometimes without vomiting or purging. There is a vulgar but erroneous notion that the leaves are not poisonous when fresh, and that they act only mechanically. It is now well ascertained that yew-leaves and berries exert a specific poisonous action both on men and cattle. If animals recover from the primary effects on the nervous system, they are liable to die after several days from inflammation of the bowels. On one occasion I examined the viscera of an ox which had died from the poisonous effects of yew-leaves. There was much inflammation, and in some parts of the intestines gangrene had taken place.

Symptoms and Appearances.—The leaves.—Dr. Percival states that a table-spoonful of the fresh *leaves* was administered to three children of five, four, and three years of age as a vermifuge. Yawning and listlessness soon succeeded; the eldest vomited a little, and complained of pain in the abdomen, but the two younger children suffered no pain. They all died within a few hours of each other.

In March 1845, a case was reported to the Dublin Pathological Society by Dr. Mollan, in which a lunatic had died from the poisonous effects of *yew-leaves.* The deceased was observed chewing the plant, probably from that perversion of appetite so commonly observed in insanity, and before the attendants had taken it from him he had succeeded in swallowing a portion of the masticated juice. He was soon afterwards suddenly seized with giddiness, prostration of strength, vomiting, coldness of the skin, spasms, and irregular action of the heart. He died in fourteen hours. On inspection, the stomach was found much distended; it contained some yew-leaves. There was emphysema in the submucous tissue, but no other abnormal change: there was some thickening with opacity of the arachnoid membrane, which might have been of old standing and due to the insanity. ('Dub. Hosp. Gaz.' May 15, 1845, p. 109.) A girl, æt. 19, took a strong decoction of the *leaves* to bring on the menses. The dose taken was a tumblerful for four successive mornings. Severe vomiting followed, and this was promoted by tepid water. Delirium came on, and the patient died eight hours after taking the last dose. It is stated that nothing of importance was revealed by an inspection of the body. ('Lancet,' 1870, 2, 471.) In another case, reported by Mr. Wallis in the 'British Medical Journal,' a girl, æt. 13, took the leaves for a similar purpose. Death took place rapidly, without any other symptom of poisoning than vomiting. On inspection there was congestion of the membranes of the brain, liver, and kidneys; a greenish colour of the contents of the stomach and intestines owing to the fragments of yew-leaves, and stellated inflammation of the mucous membranes of the stomach and bowels.

On these occasions it is difficult to obtain any knowledge of the quantity taken. The following case, communicated to me by Mr. Procter, of York, in May 1870, shows that the life of an adult may be destroyed by a very small quantity of the fresh leaves. A lunatic woman had been employed in preparing evergreen decorations for Christmas Day. Nothing unusual was observed by the nurses in attendance until about 10.30 P.M. She had had some bread and cheese with the other patients, when in about five minutes she slipped off her chair almost helpless. Her countenance turned of a dusky pallid hue, but there were no cerebral symptoms. She vomited a quantity of food mixed with a few bits of yew-leaves. She soon passed into a state of collapse, and died at 1 A.M.—in less than three hours from her first seizure. She retained her consciousness until a few minutes before she died, and admitted that she had eaten some little bits of yew, but she did not think anything of it. The broken leaflets in the vomited matters and the portions found in the stomach and bowels after death, did not amount to a teaspoonful. Yew-leaves may thus prove in small quantity a rapidly fatal poison.

In *Wilson* v. *Newberry* (Q. B., Nov. 1871) an action was brought against defendant for the loss of two horses by reason of their having eaten yew-leaves. The evidence showed that defendant had on his land yew-trees, which had been clipped, the clippings having been thrown over the hedge where the plaintiff's horses could have access to them. There was no doubt that the animals had died from eating the yew-leaves, but the defendant denied his liability, and the jury returned a verdict in his favour. It was proved that he gave no order for cutting the trees, and he was not aware that they had been cut. On a motion for a new trial (Queen's Bench, June 1872), judgment was finally

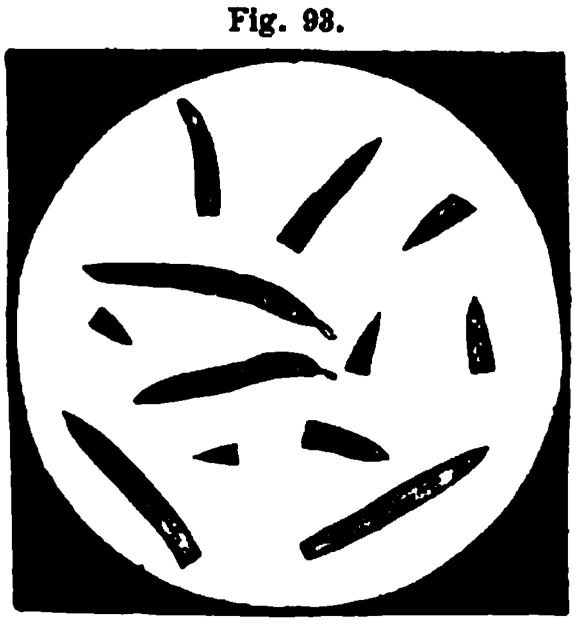
given for defendant. This case should dispel the vulgar error that fresh yew-leaves are not poisonous to cattle.

The following case of poisoning by the *berries* of the yew occurred to Mr. Hurt of Mansfield. A child, aged three years and a half, ate a quantity of yew-berries about eleven o'clock. In an hour afterwards the child appeared ill, but did not complain of any pain. It vomited part of its dinner, mixed with some of the berries. A medical man was sent for, but the child died in convulsions before he arrived. On inspection, the stomach was found filled with mucus, and the half-digested pulp of the berries and seeds. There were patches of redness in the mucous membrane, and this was so much softened that it could be detached with the slightest friction. The small intestines were also inflamed.

The following case is of more recent date. A lunatic ate a quantity of the *berries* at 10 A.M., and seven hours afterwards he was found dead sitting in a chair. On inspection of the body, the right cavities of the heart were distended with fluid blood of a dirty plum-colour. The mucous membrane of the stomach was reddened and softened with patches of black congestion. The duodenum was in a similar state. In the lower part of the small intestines there was a mass of the berries. The liver and other soft organs were much congested. ('Med. Times and Gaz.' 1870, 2, 446.) Another fatal case is recorded in this journal for 1871, 1, 386.)

The nature of the poisonous principle in the yew is unknown, and it is not certain whether, with respect to the berry, the poison is lodged in the pulp or the seed, although it is most probably in the latter. Infusion of yew-leaves, which is popularly called yew-tree tea, is sometimes used for the purpose of procuring abortion by ignorant midwives. A case of death from a person drinking this infusion is reported in the registration returns for 1838–9. In the returns for 1840 there is also one death of a female, æt. 34, referred to her having eaten the berries of the yew. The subject of poisoning by yew-leaves, in reference to their employment for purposes of abortion, has been investigated by MM. Chevallier, Duchesne, and Reynal. (See 'Ann. d'Hyg.' 1855, vol. 2, pp. 94 and 335.)

Fig. 93.



Yew-leaves and fragments, natural size.

Analysis.—Fragments of the leaves or the berries may be found in the stomach. The yew and the savin are the only coniferous poisons which grow in this country. The apex of the leaf of the yew is not so pointed as that of the savin, and the yew-leaf does not possess the peculiar odour of savin when rubbed. In the annexed illustration (fig. 93) the leaf is of the natural size, the engraving having been made from a photograph of the living leaf. Yew-berries are seen in autumn; they are about the size of a pea, of a light red colour, dull on the surface and translucent. They are open at the top, allowing a hard brown kernel to be seen. This is of an ovoid shape, and it forms the greater part of the berry. The fine red skin contains a colourless and remarkably viscid or adhesive juice, which reddens litmus paper, and has a nauseous sweetish taste.

PRIVET (LIGUSTRUM VULGARE).

The privet is not commonly enumerated among vegetable poisons. No reference is made to this plant in the works of Wibmer, Orfila, Christison, and other writers on toxicology; and yet it would appear, from the subjoined cases, for the brief particulars of which I am indebted to Mr. Ward, of Ollerton, that

the *berries* may exert a poisonous action. In December 1853, three children ate the *berries* of the privet; two of them, a boy of three years of age and a girl of six, eating them rather freely. They suffered from violent purging, and when seen by a medical man the little boy was found pulseless and cold, and before death he was frequently and violently convulsed. The girl was in a state of collapse, but rallied a little under treatment: soon afterwards she died convulsed. The surviving child, who had only tasted the berries, did not suffer, and she was enabled to point out the shrub, the berries of which they had gathered. A case has been communicated to me which occurred in November 1866, in which a child, æt. 2, died thirty-seven days after eating these berries; symptoms of irritation continuing more or less throughout. After death there were the well-marked appearances of mesenteric disease. According to Loudon, they are eaten by birds when other sources of food fail.

Dr. Moore, of Lancaster, has given me a note of two cases which show that the leaves of the privet, besides causing vomiting and purging, act upon the brain and spinal marrow. In May 1872, two children, aged twelve and eight years respectively, ate a quantity of leaves and shoots proved subsequently to have been those of the privet. The symptoms in both cases were drowsiness, convulsive twitchings, difficulty in moving about, loss of muscular power, severe vomiting and purging, the evacuations being of a greenish colour. They both recovered.

The Holly (Ilex aquifolium).

From some facts recently published the *berries* of this tree appear to produce the effects of narcotico-irritant poisoning. A boy, three years old, ate a number of them. The symptoms which followed were sickness, pain in the head and abdomen with much purging. Many of the berries of the common holly were passed in the motions; drowsiness supervened, and there was loss of consciousness. In this state (after twenty-four hours) he was seen by Mr. Barkas. His face was pale; the skin pale and cool; pulse weak and small (80). The pupils of the eyes were much contracted, but were sensible to light. The vomiting had ceased, but there was some purging. Castor oil and stimulants were given, and on the second day the child recovered ('Lancet,' 1870, 1, 573). Wibmer speaks of these berries as having merely a purgative action.

Guelder Rose (Viburnum opulus).

The poisonous properties of this plant have received but little notice. Wibmer speaks of its flowers and berries having acrid properties, and Lindley describes the plant generally as emetic and purgative. This vegetable is not, however, simply irritant to human beings; it has manifested an action on the brain and nervous system.

In October 1870, five children in a family at Sudbury suffered from symptoms of poisoning as the result of eating the *berries* of this shrub, commonly called snow-berries. Mr. W. B. Smith communicated to me the particulars. One Sunday morning the five children were simultaneously seized with violent vomiting which lasted for many hours. Mr. Smith saw them on Monday morning. The vomited matters had then been thrown away. One girl, æt. 5, was in a state of profound coma and insensibility; pupils not much dilated; pulse 40; legs rather rigid; the arms not at all so. This girl died at 8 P.M., about thirty-six hours after eating the berries. Another child suffered from similar symptoms, but in a less degree, and recovered in two or three days.

In the case of the child that died, the stomach and intestines were quite empty; there were no marks of inflammation. The brain was slightly congested on its surface but not in its substance, and there was no effusion. This is the only instance of poisoning by this plant that I have met with.

WOUNDS AND PERSONAL INJURIES.

CHAPTER 33.

SURGICAL DEFINITIONS OF A WOUND—INJURY TO THE SKIN—LEGAL DEFINITION—IMPLIES IMMEDIATE AND NOT REMOTE INJURY TO THE SKIN—IS A DISLOCATION OR FRACTURE A WOUND?—WOUNDS DANGEROUS TO LIFE—THE DANGER IMMINENT—DYING DECLARATIONS—WOUNDS PRODUCING GRIEVOUS BODILY HARM.

When a person is the subject of a wound or external injury, from the effects of which he ultimately recovers, a medical witness is often rigorously examined with respect to the precise nature of the injury, and how far it involved a risk of life. The answers to these questions may have an important influence on the defence of a prisoner, when the crime is charged under particular forms of indictment.

Definition of a Wound.—We may look in vain for any consistent definition of a wound, in works on medicine and surgery. A wound is commonly defined to be a 'recent solution of continuity in the soft parts, suddenly occasioned by external causes.' Yet they who adopt this view do not regard as wounds ruptures of the liver or spleen, burns by heated bodies, or simple dislocations and fractures, although these injuries are strictly comprehended in such a definition. The following definitions of a wound were furnished to me some years since by three eminent surgeons of this metropolis, now deceased.

'A solution of continuity from violence of any naturally continuous parts.'

'An external breach of continuity directly occasioned by violence.'

'An injury to an organic texture by mechanical or other violence.'

Owing to the unsettled meaning of the word *wound*, medical witnesses have greatly differed in their evidence, and some difficulty has arisen in the prosecution of charges for unlawful wounding. It has been asserted that, in order to constitute a wound, the *skin* should always be *broken* or injured; and this, indeed, is the interpretation commonly put upon the term. But those who adopt this definition do not regard *burns*, produced either by heated metals or corrosive liquids, as wounds, although the skin may be broken or destroyed. Technical difficulties of this kind, which can only lead to the embarrassment of witnesses and to the acquittal of prisoners charged with serious offences, might be avoided if the medical witnesses of England would adopt the comprehensive definition sanctioned by the legal tribunals of certain States on the Continent, namely, that 'a wound includes any personal injury, suddenly arising from any kind of violence applied externally, whether such injury is external or internal.' It may appear contrary to surgical propriety to designate a burn or fracture as a wound; but the common surgical definitions will be found on examination to be utterly inconsistent with each other. The use of such vague definitions in medical evidence has frequently led to acquittals, not upon the merits of a case, but upon mere technicalities. It is desirable, therefore, that some comprehensive definition should be generally adopted. In reference to medical evidence we are bound to regard the wants of justice rather than the strict rules of surgery. If medico-legal cases fail from differences

respecting the meaning of scientific terms among surgical writers, it is time that some fixed rule should be adopted. While the practice of surgery cannot possibly suffer by such an innovation, the administration of the law will be rendered more efficient. The statute 14 and 15 Vict. c. 100, has, however, supplied a remedy for some of the evils which have hitherto arisen from a misdescription of personal injuries in indictments.

Legal definition.—It cannot be denied that an alteration in the use of medical terms must, in order to be attended with any good effects, receive the support of our legal authorities. This, probably, would not be long withheld, if good reasons for the change were afforded by medical witnesses. It was at one time held that no injury was a wound in law, unless the continuity of the skin was broken; so that in a case in which blows were inflicted with a hammer or iron instrument sufficient to break the collar-bone, and violently bruise but not break the skin, it was held not to be a wounding within the statute. (*Reg.* v. *Wood*, 'Matthews' Digest,' p. 415.) The Act 1 Vict. c. 85 provided for the punishment of persons guilty of inflicting such severe injuries, but left the legal signification of the word 'wound' unsettled. The 14 and 15 Vict. c. 100 is more precise, but this also avoids any legal definition of a wound.

In order to remove any difficulty in future cases, and to put an end to conflicting decisions, the Commissioners for codifying the Criminal Law suggested that *internal* breaches of continuity should be included under the term 'wound.' They have defined a wound to be '*that whereby the skin is divided either externally or internally.*' The late Mr. Justice Talford objected to this definition, because, in his opinion, the division of the skin internally without a division externally was impossible. The use of the word 'skin' leads to ambiguity; and, in this instance, it shows that those who frame laws are not sufficiently careful in the selection of medical terms. The skin consists of the cuticle and cutis. It has been held on more than one occasion that an abrasion of the *cuticle*, or outer skin only, is not a wound in a legal sense. A man was tried at the Central Criminal Court in August 1838, on a charge of cutting and wounding the prosecutor. The prisoner struck the prosecutor a severe blow on the temple with a heavy stone bottle, which was thereby broken in pieces. The prosecutor fell senseless, and it was a long time before he recovered from the effects of the violence. The medical witnesses in this case underwent a rigorous cross-examination by the prisoner's counsel, respecting the meaning of the word 'wound.' They said that there had been a separation of the *cuticle* or outer skin of the temple, but not of the cutis, and that there was no absolute wound in the usual acceptation of the word. They further deposed that the prosecutor had lost the sight of his left eye, and the hearing of his left ear; and he was for a considerable time in a state of great danger, from which he had scarcely recovered. The prisoner's counsel contended that the injuries were not such as to constitute cutting and *wounding* in law. The judges said, that in order that a wound, in contemplation of law, should have been inflicted, it was necessary that the *whole skin*, and not the mere *cuticle*, should have been separated and divided; and as the evidence did not show distinctly that there was such a wound, those counts of the indictment could not be sustained. The prisoner was, therefore, found guilty of a common assault. A division of the *cutis* or true skin has always been regarded as a wound, whether blood is effused or not. The boundary of the cutis towards the inside of the body is not easily determined; since there is a gradual transition of the cutis into the subjacent fibrous tissue, in which the fat and sudatory glands are contained. According to Quain and Sharpey ('Elements of Anatomy,' vol. 1, p. 285), the cutis measures in thickness from a quarter of a line to a line and a half (a line being about one-twelfth of an inch). It is thicker in some parts than in others. Taking the true skin, or

cutis, at the thickness usually assigned, it is impossible to conceive that such a very thin layer of membrane as this can be divided internally without an external division being produced. Allowing the maximum thickness of the eighth of an inch, it would be difficult for any medical man to affirm that only a fractional part of this membrane had been divided internally, when there was no evidence of external separation; and it would be certainly impossible for him to prove it. What the Commissioners probably mean, is a division of the structures beneath the skin. Their definition is, however, vague and unsatisfactory, because it does not reach an important class of cases in which wounds are inflicted not in the skin, but in the *mucous membrane* lining the outlets of the body. Thus cuts, punctures, or lacerations of the lining membrane of the nostrils, mouth, and throat, rectum and vagina, are undoubtedly wounds, although the skin may not be directly touched by the weapon. Injuries of a serious description have thus been frequently inflicted on women by cutting and pointed instruments: they have been hitherto properly regarded as wounds, but they would not be comprised under this term by a strict adherence to the proposed definition. Skin and mucous membrane are not one and the same structure. It is, however, satisfactory to find that there is at least one legal case on record, in which injuries to the mucous membrane, not involving the external skin, have been judicially pronounced to be wounds. In Scotland, so far as I know, the matter has never been contested. In the subjoined case the prisoner was charged with maliciously *wounding* a mare. He had thrust forcibly down the throat of the animal a stone, which had torn the throat and gullet. It was objected that the injury was not a wounding within the statute, the parts injured being *internal*, and there being no proof of any external blow or violence. The judge who tried the case was of opinion that it fell within the statute. Blood had flowed from the broken skin or membrane lining the throat, and the stone was forced into the flesh; and it had been held that the injury need not be 'external' to bring the case within the statute. The prisoner was convicted. (*Reg.* v. *Bolton*, Norwich Summer Assizes, 1849.) Under this head would fall injuries to the brain produced by pointed instruments passed up the nostrils through the ethnoid bone. Other cases, in which the vagina in females has been thus wounded, are given under the section of 'Wounds of the Genital Organs.' (See case, post, p. 461.)

Do all breaches of continuity involving the skin or mucous membrane, fall under the head of wounds? Burns appear to constitute an exception; but there is no reason why a burn producing a destruction of the skin, as by a red-hot poker, should not be regarded and treated in law as a wound. No definition of a wound, medically or legally, can be so contrived as to exclude such an injury. The question, however, mainly to be considered is this—May not a breach of continuity be regarded as a wound, although neither the skin nor the mucous membrane is directly implicated in the injury? Is a simple dislocation or fracture a wound? Is a rupture of the bladder, liver, or other organ, suddenly caused by external violence without implicating the skin, to be regarded as a wound? Is a compound dislocation or fracture a wound? No definition yet constructed has excluded these last-mentioned injuries, because the skin is always involved. In a case before the Queen's Bench in November 1847, it was even held that a simple *dislocation* was a wound. An action was brought against a medical practitioner for negligence in the treatment of a dislocation of the arm, and a verdict was returned for the plaintiff. An application was made to the Court for a new trial, on the ground of a misdirection of the Chief Baron, who tried the case. The declaration alleged that the plaintiff had employed the defendant, who was a surgeon, for the treatment and cure of certain *wounds*, fractures, bruises, complaints, and disorders; but the evidence

showed that the defendant had been employed to cure the plaintiff of a *dislocated arm.* At the close of the plaintiff's case, it was submitted that there was no word in the declaration which was applicable to the case, but this objection was overruled. A dislocation, it was argued, was neither a wound, bruise, nor fracture; and the words 'complaint and disorder' were not at all applicable to a surgical case, but to internal complaints which required to be treated medically. Lord Denman, in delivering the judgment of the Court, said, 'It is rather strange that the pleader should have omitted the most appropriate word; but we think the Chief Baron was quite right.'—Rule refused.

In reference to simple *fractures*, it was held in *Rex* v. *Wood* (4 'C. and P.' p. 381), that a fracture of the collar-bone was not a wounding within the statute, because the *skin* was not broken. In more recent cases, however, this decision has been properly overruled. Thus in *Reg.* v. *Smith* (8 'C. and P.' p. 173) the prisoner struck prosecutor with an iron hammer on the side of the face. A surgeon deposed that the lower jaw was broken in two places, and that the *skin* was broken *internally* but not *externally*. There was not a great deal of blood effused. On the objection being taken that this was a *fracture* and not a wound within the statute, Denman, C.J., observed, 'If it is the immediate effect of the injury, we think we cannot distinguish this from the cases already decided;' and Parke, J. (in summing up), said, 'We were of opinion that there was a wound, and upon consideration I am more strongly of that opinion than I was at the outset. There must be a wounding; but if there be a wound (whether there be an effusion of blood or not), it is within the statute whether the wound is *internal* or *external*.' The same point arose in *Reg.* v. *Warman* (1 'Denison, C. C.' p. 183). This was an indictment for inflicting a mortal *wound*; and a question arose whether it was supported by proof of a blow which caused an *internal* breach of the skin (although externally there was only the appearance of a bruise). The death of the deceased had been caused by a single blow on the head by a piece of wood; and the medical witness described the injury as follows: 'I found on examining the head no *external* breach of the skin. I found a collection of blood in the back part of the head: the deceased died from effusion of blood, which pressed on the brain. On examining the scalp, I found a collection of blood between the scalp and cranium, just above the spot where, within the cranium, I had found the pressure on the brain. I call that a contused wound with effusion of blood; that is the same thing as a bruise. The internal part of the skin was broken. Medically, we call the breaking of the skin, whether broken externally or internally, a wound.' This case was reserved for the twelve judges. All thought that this *internal* injury was a sufficient wound to support the allegation in the indictment.

In each of these cases the Court appears to have been misled by the medical witnesses affirming that the skin (cutis) was broken internally but not externally. There is no doubt that they intended by this, not the cutis merely, but the areolar fatty tissue and soft parts beneath. Their evidence has, however, served to mislead the Commissioners, and to induce them to propose a faulty and erroneous definition. I know no instance in which a rupture of the bladder or liver, without any external injury, has been called a wound, although the term might be applied with as much propriety to this kind of injury as to a simple fracture or dislocation. The brain is sometimes lacerated by a blow on the skull which does not break the scalp or the skin of the head. This must, however, be regarded as a wound of the brain; it admits of no other description. Two of the surgical definitions given ante, p. 449, include all injuries of this kind. Archbold describes a wounding to be where 'the violence is so great as to draw blood, by striking or stabbing with a sword, knife, or other instrument, or by shooting or striking with a cudgel, the fist, or the like;'

while 'a wound includes incised, punctured, lacerated, contused, or gun-shot wounds.' ('Pleading and Evidence in Criminal Cases,' 15th edition, by Welsby, 1862, pp. 567, 572.) In the first part of this quotation, the 'drawing of blood' is made a character of a wound. This is inconsistent with the further statement respecting lacerated, contused, and gun-shot wounds, for these injuries are not necessarily accompanied with the effusion of blood: and in some of the most fatal wounds of this class no blood is effused. From the legal decisions above given, it appears that simple fractures and dislocations, as well as injuries to the mucous membrane of the outlets, are considered to be wounds. No doubt when the question arises, ruptures of the bladder and other organs will be equally considered as wounds for all legal purposes, although the skin may not be involved. (From this it appears that the best definition which we can give of the word 'wound,' whether in a medical or legal sense, is that it implies 'a breach of continuity in the structures of the body, whether external or internal, suddenly occasioned by mechanical violence.' This would include injuries to the skin or mucous membrane, dislocations and fractures, whether simple or compound, and ruptures of the viscera.)

Wounds dangerous to life.—A medical witness is sometimes asked, whether a wound is or is not dangerous to life. In reference to persons charged with an attempt to murder or maim, a written medical opinion, or a deposition, may be demanded of a surgeon by a magistrate, in order to justify the detention of prisoners. The meaning of the words '*dangerous to life*' is left entirely to the professional knowledge of a witness. It is not sufficient on these occasions that he should make a naked declaration of the wound being dangerous to life; he must, if called upon, state to the Court satisfactory reasons for this opinion; and these reasons are rigorously inquired into by counsel for the defence. As a general principle it would not be proper to consider those wounds dangerous to life in a legal sense, in which the danger is not *imminent*. A wound of a great blood-vessel, of any of the viscera, or a compound fracture with depression of the bones of the head, must in all instances be regarded as bodily injuries dangerous to life; because in such cases the danger is imminent. Unless timely assistance be rendered, these injuries will most probably prove fatal, and, indeed, they often destroy life in spite of the best surgical treatment. When, however, the danger is remote, as in a puncture or laceration of the hand or foot, which may be followed by tetanus, or in a laceration of the scalp, which may be followed by erysipelas, or in penetrating wounds of the orbit, which may be attended by fatal inflammation of the brain or its membranes, the case is somewhat different. Such injuries as these are not directly dangerous to life—they are only liable to be attended with danger in certain cases, and under certain circumstances; hence the medical opinion must be qualified. The law, on these occasions, appears to contemplate the direct and not the future or possible occurrence of danger; if the last view were adopted, it is clear that the most trivial lacerations and punctures might be pronounced dangerous to life; since tetanus or erysipelas, proving fatal, has been an occasional consequence of very slight injuries. A difference of opinion will often exist among medical witnesses, whether a particular wound is or is not dangerous to life. Unanimity can only be expected when the judgment and experience of the witnesses are equal. The rules for forming an opinion in these cases, will, perhaps, be best deduced from the results of the observations of good surgical authorities in relation to injuries of different parts of the body. This will form a subject for consideration hereafter.

Dying declarations.—The wound may be of such a nature as to cause death speedily, so that a practitioner may arrive only in time to see the wounded person die. In this case the dying person may make a declaration or statement as to the circumstances under which the wound was inflicted: he may also mention

the names of the parties by whom he was assaulted. This *dying declaration* or statement, according to the circumstances under which it is made, may become of material importance in the prosecution of a party charged with homicide. It is therefore proper that a practitioner should observe and make notes of the *exact condition* of the dying person: whether, at the time he makes the statement, he is under the conviction that he must soon die, either expressed in language or implied by his conduct. According to some authorities, it is not necessary that a man should declare that he believes himself to be dying, in order to render his statement admissible; but there must be evidence that at the time of making it he was under the full conviction of approaching or impending death. When it is made clear to the Court, by medical or other testimony, that the person making the statement believed that he was about to die, it will be received as evidence against the accused; for the law supposes that, under the sense of impending dissolution, all interest in this world is taken away, and that the near contemplation of death has the same powerful effect upon the mind as the solemn obligation of an oath. It is presumed that there can be no disposition on the part of a dying person to wilfully misrepresent facts, or to state what is false. Much, therefore, often depends on the conduct of a medical practitioner under such circumstances, for the usual method of testing the truth of a statement by cross-examination is, of course, out of the question: it must, if admitted at all, be received as it was made.

In *Reg.* v. *Bayley* ('Exchequer Chamber,' Jan. 1857), in which it appeared that the surgeon had given some hope to the dying person before the declaration was made, while the declarant stated that he did not himself *believe* that he could recover ultimately, its reception was objected to on the part of the prisoners because the surgeon had given the man some hope. He died two days afterwards. Pollock, C.B., ruled that the real belief of the dying man was the question, and here he had said, notwithstanding the opinion of the surgeon, he believed he could not recover. In the case of *Reg.* v. *Harvey* (Exeter Summer Assizes, 1854), the chief evidence against the prisoner consisted of certain statements made by the deceased. They were admitted by Wightman, J., because it appeared clearly from the evidence that when they were made, deceased had expressed an opinion that she should die *shortly*, and had not changed that opinion. Her whole conduct intimated that she had no hope (or belief) of recovery. It was observed on this occasion that the medical and other witnesses were more desirous of telling the deceased her state, than of ascertaining what her own opinion was. In some recent cases (*Reg.* v. *Wanstall*, Leeds Autumn Assizes, 1869, and *Reg.* v. *Pettingill*, C. C. C., April 1872), Cleasby, B., held that before a declaration could be admitted as evidence, even when taken down by a magistrate, there must be clear proof that the person making it was in momentary expectation of death, or that death was imminent. In *Reg.* v. *Londesborough* (York Lent Assizes, 1871), Mr. Justice Brett declined to receive a statement because the evidence went no further than this—the dying youth said he thought he should not get better; and *Reg.* v. *Barrett* (Leeds Lent Assizes, 1869), Cleasby, B., rejected a statement in which the expression used by the deceased was—she thought she should not recover. This was also the opinion of the surgeon at the time the statement was made, but this did not prove that she believed her death to be impending. In the case of *Jenkins* (Crown Cases Reserved, April 1869), a statement was rejected because the dying person, in using the expression 'I have no hope of my recovery,' requested that the words 'at present' should be added.

One test of the correctness of a statement is, that the dying person has given at different times and to different persons the same account, but in different language, and that the details are consistent with each other. Even if he recovers after making it, and lives some hours or days, the statement will be admissible

provided it was made under the sense or impression of almost immediate death. It is the proof of the sense of impending dissolution which determines its admissibility. Chief Justice Erle, in Seton's case (*Reg.* v. *Pym*, Hants Lent Assizes, 1846), said, 'The law admits these declarations, not because recovery is impossible, but because there is in the mind of the person making them the conviction of approaching death.'

It is no part of the duty of a medical witness to form a judgment on this important subject. He should give the statement as it was made, and leave the Court to decide upon its admissibility from the circumstances carefully observed by him with respect to the condition of the patient. He should not render himself officious in extracting information. He should receive that which is *voluntarily uttered*, and, either immediately or on the earliest possible opportunity, write down the statement in the *identical* words, carefully avoiding his own interpretation or any paraphrase of them. On no account should leading questions be put—and any question should be simply confined to the purpose of explaining what may appear ambiguous or contradictory in the declaration itself. It is well known that when death takes place from violence, especially when this proceeds from loss of blood or a wound of the head, delirium is apt to supervene, or the intellect of the dying person becomes confused. Hence great caution should be used in receiving a declaration in such cases, since it may lead to the implication of innocent persons. It is also proper to remark, that the identity of a person is, under these circumstances, liable to be mistaken; and that it is in general an injudicious proceeding to take a suspected party before one who is dying, in order that he may be identified. At this time there may be a half-delirious state of mind, not easily recognized by non-professional persons; and confessions or statements then made, should, when they implicate other persons and are not strongly corroborated by circumstances, be regarded with great suspicion. I have heard of a case occurring within the last few years, where a statement affecting seriously another person was incautiously received by a medical man; and but for the clear establishment of an alibi, might have led to the trial of an innocent individual upon a false charge. A fatal mistake of this kind was made many years since in London. A woman was maltreated by some men on Kennington Common. She was taken to St. Thomas's Hospital, and while dying from the effects of the violence, a suspected party was brought before her, as one of the supposed assailants. She stated that he was one of those who had assaulted her. The man was tried, upon her declaration respecting his identity—found guilty and executed; but a year after the execution, his innocence was satisfactorily established by the discovery of the real murderers!

In *Reg.* v. *Qualter* (Stafford Lent Assizes, 1854), the escape of a criminal was attributed to the neglect of the medical attendant in reference to a dying declaration. The deceased was grossly ill-treated, as it was alleged, by the prisoner and others. He lingered from the 19th of June until the 8th of August, 1853, when he died from the injuries received. On his death-bed he made certain statements implicating the prisoner, and upon these the case for the prosecution chiefly rested. Qualter was tried for the murder. The deceased told his wife that he knew he should not recover, but this was *after* he had made the statement against Qualter, and it was therefore inadmissible. A similar declaration affecting the prisoner was subsequently made by the deceased to the surgeon; and it seems that the surgeon had told the wife that her husband would not recover, but not in the presence or hearing of the deceased: hence the declaration made by deceased to him was inadmissible, and the prisoner was acquitted. There was a want of proof, in fact, that the statement to either had been made by the dying man while he was under the conviction of approaching death. Had the surgeon informed the deceased that he

could not recover, or had he made the announcement to the wife in his presence and hearing, the declaration might have been made under circumstances to render it admissible. It is advisable, in all cases when a medical man perceives that the recovery of a wounded person is impossible, that he should take the first opportunity of stating his opinion to the wounded person in the presence of others, so that the ends of justice may not be defeated by reason of the non-observance of these legal forms. (See the case of *Reg.* v. *Harvey*, Exeter Summer Assizes, 1854.) His duty does not end here. In spite of the medical opinion thus expressed, the dying person may himself have some hope or belief that he shall recover. It is therefore his duty to elicit from the person wishing to make the statement what his opinion of his condition is—whether he himself actually believes that he is dying, or has some expectation of recovery.

Wounds causing grievous bodily harm.—A wound may not be dangerous to life, but it may have produced '*grievous bodily harm.*' This question is sometimes put, although the usual practice is to leave it to be drawn by the jury as an inference from a professional description of the injury. These words have a vague signification; but it would perhaps be difficult to substitute for them others less open to criticism. They evidently refer to a minor description of offence, and are applied commonly to those injuries which, while they do not actually place life in danger, may be attended with considerable personal inconvenience, or be in some way detrimental to the health of the wounded party. The late C. B. Pollock stated on one occasion that 'grievous bodily harm' would reasonably apply to such an injury as would render medical treatment necessary. It is always a question for a jury, whether the *intent* of the prisoner, in inflicting a wound, was or was not to produce grievous bodily harm. Sometimes the nature or the situation of a wound, as well as the kind of weapon used, will at once explain the intent: so far the medical witness may assist the Court, by giving a plain description of the injury, as well as of the consequences with which it is usually attended. It may happen either that the wound itself is not of a serious nature, and yet the intention of a prisoner may have been to do grievous bodily harm to the wounded person, or, as in the following case, the injury may be really serious, and yet the prisoner may not have intended to do grievous bodily harm. A man was indicted for feloniously wounding a girl, with intent to do grievous bodily harm. He kicked her in the lower part of her abdomen—the surgeon described the injury as of the most serious character, and said that at one time he considered the life of the prosecutrix in danger. She was still suffering, and would probably feel the effects of the injury for the rest of her life. The judge, in summing up the case, told the jury that the material question for them to consider was the *intent* of the prisoner. It was not because serious injury was the result of a prisoner's act, that they were therefore to infer his intention was to do that injury; and they were to judge, from all the circumstances, whether, at the time he kicked the prosecutrix, he intended to do her grievous bodily harm, as was imputed to him by the indictment, or whether he was merely guilty of a common assault. He was found guilty of a common assault. (*Reg.* v. *Haynes*, C. C. C., September 1847.) In *Reg.* v. *Davis* (Chelmsford Autumn Assizes, 1871) a man was charged with wounding with *intent* to do grievous bodily harm. It appeared from the medical evidence that the prisoner, half drunk, and during a quarrel, suddenly stabbed the prosecutor, inflicting a dangerous wound, with which he was laid up for a month. For a fortnight he was in danger. It was contended that there was no intent to produce grievous bodily harm. Bramwell, B., said the jury might satisfy themselves on that point by looking to the circumstances of the case. Could a man inflict such a wound as this without having an intention to inflict grievous bodily injury? The prisoner was not so drunk but that he knew what he was doing, and all the circum-

stances showed premeditation and intention—the nature of the wound, the weapon used, and the part of the body struck where an injury was so likely to be dangerous. The prisoner was found guilty of the intent. In cases of this description, the intent with which a wound was inflicted is usually made out by evidence of a non-medical kind. (See also the case of *Reg.* v. *Maslin*, Devizes Summer Assizes, 1838.)

These are the principal medico-legal questions connected with wounds when the wounded person is seen while *living*. We will suppose, however, that the wounded person is found dead, and an examination of the body is required to be made. The most difficult part of the duty of a medical jurist now commences. Among the numerous questions which here present themselves, the first which demands examination is, whether the wound was inflicted on the body before or after death.

CHAPTER 34.

EXAMINATION OF WOUNDS IN THE DEAD BODY—ALL THE CAVITIES SHOULD BE INSPECTED—ACQUITTALS FROM THE NEGLECT OF THIS RULE—CHARACTERS OF A WOUND INFLICTED DURING LIFE—OF A WOUND MADE AFTER DEATH—EXPERIMENTS ON AMPUTATED LIMBS—CAUTION IN MEDICAL OPINIONS—WOUNDS OR INJURIES UNATTENDED WITH BLEEDING—ECCHYMOSIS FROM VIOLENCE—EVIDENCE FROM ECCHYMOSIS—ECCHYMOSIS FROM NATURAL CAUSES—IS ECCHYMOSIS A NECESSARY RESULT OF VIOLENCE?

Examination of Wounds.—In examining a wound on a dead body, it is proper to observe its situation, extent, length, breadth, depth, and direction:—whether there is about it effused blood, either liquid or coagulated, and whether there is ecchymosis, *i.e.* a livid discoloration of the skin from the effused blood. It should also be ascertained whether the surrounding parts are swollen, whether adhesive matter or pus is effused, whether the edges of the wound are gangrenous, or any foreign substances are present in it. Care must be taken that putrefaction is not mistaken for a gangrenous condition of the wound. The wound may be examined by gently introducing into it a bougie, and carrying on the dissection around this instrument, avoiding as much as possible any interference with the external appearances. The preservation of the external form will allow of a comparison being made at any future time between the edges of a wound and a weapon found on a suspected person. (Of all these points *notes* should be taken, either on the spot or immediately afterwards. In the dissection, every muscle, vessel, nerve, or organ involved in the injury, should be traced and described.) This will enable a witness to answer many collateral questions that may unexpectedly arise during the inquiry. Another point should be especially attended to. A medical practitioner has frequently contented himself by confining his dissection to the injured part, thinking that on the trial of an accused party the questions of counsel would be limited to the situation and extent of the wound only, but this is a serious mistake. If the cause of death be at all obscure, on no account should the inspection be abandoned until all the important organs and cavities of the body have been closely examined; since it may be affirmed that a natural cause of death might have existed in that organ or cavity which the medical witness had neglected to examine. (*Reg.* v. *Solloway*, Abingdon Autumn Assizes, 1860.) It rests with

the practitioner to disprove the probability thus urged by counsel, but he has no facts on which he can base an opinion, and the prisoner, of whose guilt there may be but little doubt, will have the benefit of his inattention and be acquitted by the jury.

In the medical reports on the examination of the bodies of wounded persons, care should be taken to avoid the introduction of any remarks in the form of inferences from or comments on the facts of the case. At the trial of *McLachlan* (Glasgow Sept. Circuit, 1862), Lord Deas objected to the statements in the medical report, 'that the body of deceased had been found under circumstances of great suspicion,' and 'that there were marks of a severe conflict.' When the witness was cross-examined on the medical facts which had led him to the conclusion that there had been a 'severe conflict,' it resolved itself into the statement that there were marks (of blood) on the flags, which indicated that the body had been dragged along the floor *after death*; but he was unable to mention any medical facts by which this form of expression could be justified. Inferences of this kind should, as a rule, be entirely excluded from medical evidence and reports.

In making an inspection of the body, the state of the *stomach* should not be overlooked. Death may have been apparently caused by violence, and yet really be due to poison. Wildberg was called upon to examine the body of a girl who had died while her father was chastising her for stealing, apparently from the effects of the violence. On the arms, shoulders, and back many marks of blows were found; and under some of them blood was effused in large quantity. The injuries, although severe, did not, however, appear sufficient to account for sudden death. He therefore proceeded to examine the cavities, and on opening the stomach, he found it very much inflamed and lined with a white powder, which was proved to be arsenic. It turned out that on the theft being detected, the girl had taken arsenic for fear of her father's anger: she vomited during the flogging, and died in slight convulsions. Upon this Wildberg imputed death to the arsenic, and the man was discharged. The late Dr. Geoghegan communicated to me a case which occurred in Ireland in 1853, in which a gentleman, having taken eleven grains of strychnia, threw himself out of a window and sustained great bodily injury. The surgeon finding so much more spasm than could be accounted for by the violence sustained, discovered the real state of the case from the patient's confession. There was also evidence of the purchase of the poison. The cause of death may be easily assigned in such cases when the circumstances are known; but it is evident that without proper inquiry and great care in conducting examinations after death, the apparent may be sometimes mistaken for the real cause. (For some interesting cases and good practical suggestions on this subject, see Belloc, 'Cours de Méd. Lég.' 148.) In the summer of 1864, an inquest was held at Kilburn on a young man who committed suicide by throwing himself from the window. He lived sufficiently long to inform his medical attendant, Mr. Nelson, that he had first taken corrosive sublimate, he then cut open his wrist that he might bleed to death, and finding this ineffectual, he threw himself from the window. Even when there may be no suspicion of poisoning, it will be necessary to observe the state of the stomach and its contents—*i.e.* to determine whether it contains food, the nature of the food, and the degree to which it may have undergone digestion. In *Reg.* v. *Spicer* (Berks Lent Assizes, 1846), the falsehood of one part of the prisoner's defence was made evident by an examination of the stomach. The deceased was found dead at the foot of a stair. The prisoner stated that *after* he and his wife had had their dinner, he heard a fall. The woman had died instantaneously, and the fall was heard by neighbours at or near the dinner-hour. Mr. Hooper, the medical witness, found the stomach quite empty; there was

no trace of food. It was therefore clear that this part of the prisoner's story was untrue, as, had the deceased died immediately after dinner, some portion of undigested food would have been found.

Description of Wounds.—It is impossible to impress too strongly on the mind of a medical witness, that in describing the wounds which he has found on the examination of a body, he should employ plain and simple language, and avoid as much as possible the use of technical or professional terms. The natural desire of a good witness is to make himself understood: but this cannot be accomplished if he clothes his ideas in language which is incomprehensible to educated men of the legal profession, and *à fortiori* to the class of men who constitute juries. There are few Assizes which do not afford many illustrations of the injury done to scientific evidence, and the clear understanding of a case, by the technical language in which it is given. A medical witness should, for his own credit and for that of the profession to which he belongs, employ plain and simple language in describing a wound, as well as in giving his evidence generally. (See page 30.)

Characters of a wound inflicted during life.—If we find about a wound marks of gangrene, the effusion of adhesive or purulent matter, or if the edges are swollen and enlarged, and cicatrization has commenced, it is not only certain that the injury must have been inflicted before death, but that the person must have lived some time after it was inflicted. Marks of this description will not, however, be commonly found when death has taken place within ten or twelve hours from the infliction of the injury. A wound which proves fatal within this period of time will present throughout much the same characters. Thus, supposing it to have been *incised*, there will be traces of more or less bleeding, the blood having chiefly an arterial character, and it will be found coagulated where it has fallen on surrounding bodies. The edges of the wound are everted, and the muscular and cellular tissue around is deeply reddened by effused blood. Coagula or clots are found adhering to the wound, provided it has not been interfered with. (The principal characters of a wound inflicted during life are, then, the following: 1. Eversion of the edges owing to vital elasticity of the skin. 2. Abundant hæmorrhage or bleeding, often of an arterial character, with general diffusion of blood in the surrounding parts. 3. The presence of coagula.) The wound may not have involved any vessel, and there may be no appearance of bleeding, still the edges will be everted, and the muscles and skin retracted. By an observation of this kind made on the body of a new-born child (case of *Elphick*, March 1848), Mr. Prince was enabled to state that the child was living when it was inflicted, an opinion afterwards confirmed by the confession of the mother.

Characters of a wound made after death.—If the wound on a dead body be not made until twelve or fourteen hours have elapsed from the time of death, it cannot be mistaken for one produced during life. Either no blood is effused, or it is of a venous character, *i.e.* it may have proceeded from some divided vein. The blood is in small quantity, commonly liquid, and it does not coagulate as it falls on surrounding bodies, like that poured out of a wound in the living. The edges are soft, yielding, and destitute of elasticity; they are therefore in close approximation. The cellular and muscular tissues around are either not infiltrated with blood, or only to a very partial extent. There are no coagula within the wound. In experimenting upon amputated limbs, I have found these characters in a wound produced two or three hours after death, although they are best seen when the wound is not made until after the body has lost all its animal heat. (In wounds on the dead body, divided arteries have no marks of blood about them, while in the living body the fatal bleeding commonly proceeds from these vessels.) Hence in a wound on the living, it will be found that the surrounding vessels are empty. The chief

characters of a wound after death are, therefore: 1. Absence of copious bleeding. 2. If there is bleeding it is exclusively venous. 3. The edges of the wound are close, not everted. 4. There is no diffusion of blood in the cellular tissue. 5. There is an absence of coagula. But it may happen that a wound has been inflicted soon after the breath has left the body, and while it was yet warm. The distinction between a wound then made and one made during life is not so well marked as in wounds inflicted at a later period after death. Observations of this kind on the human subject must of course be purely accidental; and there are many obstacles to the performance of experiments on the recently dead.

In conjunction with the late Mr. Aston Key, I performed some experiments on recently amputated limbs. *Two minutes* after a leg had been amputated a deeply incised wound was made in the calf. At the moment that the wound was made, the skin retracted considerably, causing a protrusion of the adipose substance beneath; the quantity of blood which escaped was small; the cellular membrane, by its sudden protrusion forwards, seemed mechanically to prevent its exit. The wound was examined after the lapse of twenty-four hours: the edges were red, bloody, and everted; the skin was not in the least degree swollen, but merely somewhat flaccid. On separating the edges, a small quantity of fluid blood escaped, but no coagula were seen adhering to the muscles. At the bottom of the wound, however, there was a small quantity of coagulated blood; but the coagula were so loose as readily to break down under the finger. In a second experiment, *ten minutes* after the separation of the member from the body, a wound of similar extent was made on the outer side of the leg, penetrating to the deep-seated layer of muscles. In this case the skin appeared to have already lost its elasticity, for the edges of the wound became but slightly everted, and scarcely any blood escaped from it. On examining the leg twenty-four hours afterwards, the edges of the incision were pale, and perfectly collapsed, presenting none of the characters of a wound inflicted during life. Still, at the bottom of the wound and inclosed by the divided muscular fibres, there were some coagula of blood; but these were fewer than in the former experiment. A portion of liquid blood had evidently escaped, owing to the leg having been moved. Other experiments were performed at a still later period after the removal of the limbs; and it was found that in proportion to the length of time suffered to elapse before the production of a wound, so were the appearances less distinctly marked; that is to say, the less likely were they to be confounded with similar injuries inflicted upon a *living* body. When the incised wound was not made until *two or three hours* after the removal of the limb, although a small quantity of liquid blood was effused, no coagula were found.

It is necessary to remember that, when an incised wound is the cause of death, the person dies either immediately, in which case there is copious bleeding from the wounded organ or some large vessel, or he dies after some time, in which case, as the wound continues to bleed during the time that he survives, the longer he lives the more copious will be the effusion of blood. In a wound inflicted after death, and while the body is warm, nothing of this kind is observed. Unless the weapon injure one of the large veins, the bleeding is generally slight, so that the *quantity of blood* lost may assist us in determining whether the wound was made during life or after death. When the body has been moved, and all marks of blood effaced by washing, rules of this kind cannot serve a medical witness:—the time at which the wound was actually inflicted must then be deduced from other circumstances. In the case of *Greenacre*, who was convicted in 1837 of the murder and mutilation of a female, this formed a material part of the medical evidence. The head of the deceased had been severed from the body, and the question was, whether

this severance had taken place during life or after death. The prisoner alleged in his defence that it was after death: but the medical evidence went to establish that the head must have been cut off while the woman was living, but probably after she had been rendered insensible by a blow on that part, the marks of which were plainly visible. This medical opinion was founded on two circumstances. The muscles of the neck were retracted, and the head was completely drained of blood, showing that a most copious and abundant flow must have ensued at the time of separation, and therefore indicating that the circulation was probably going on at that time. On cutting off a head after death a small quantity of blood may escape from the jugular veins: but this soon ceases, and the quantity lost is insufficient to affect materially the contents of the vessels of the head. The chief medical witness, Mr. Girdwood, expressed himself with proper caution, by stating, in answer to a question from the judge, that the wounds in the neck had been inflicted either during life or very shortly after death, while the body still preserved its warmth. The circumstantial evidence tended to show that the deceased was first stunned, and that her head was cut off while she was in a state of stupor.

A post-mortem *lacerated* wound occurring as the result of accident, may be attended with such an effusion of blood as to deceive a medical man, unless all the facts of the case are known. In another part of this work (page 94), I have described a case communicated to me by Mr. Gibson, the surgeon of Newgate, in which, except from the proof of accident after death, a surgeon might have come to the conclusion that the deceased had been maltreated during life. In any case in which it is doubtful whether a wound was inflicted on a living or dead body, it will be proper to adopt the same cautious mode of expressing a medical opinion: since it must be remembered there are no decisive characters by which wounds of the kind referred to can be distinguished; and a medical witness is as likely to be wrong as right in selecting either hypothesis. It is a considerable step in evidence, when we are able to assert that a particular wound, found on a dead body, must have been inflicted either during life or *immediately* after death; for it can scarcely be supposed that in a case calling for criminal investigation, anyone but a murderer would think of inflicting upon a body immediately after death, a wound which would assuredly have produced fatal effects had the same person received it while living. So soon as such an opinion can be safely expressed by a witness, circumstantial evidence will often make up for that which may be, medically speaking, a matter of uncertainty.

Wounds or injuries unattended with hæmorrhage.—The copious effusion of blood has been set down as a well-marked character of a severe wound received during life; but this observation applies chiefly to cuts and stabs. Lacerated and contused wounds of a severe kind are not always accompanied by much bleeding, even when a large blood-vessel is implicated. It is well known that a whole member has been torn from the body, and that little blood has been lost; but in such cases coagula or clots of blood are commonly found adhering to the separated parts, a character which indicates that the wound was inflicted either during life or soon after death, while the blood was warm and fluid. When a lacerated or contused wound involves a highly vascular part, although no large blood-vessel may be implicated, it is liable to cause death by loss of blood. In a case tried at the Liverpool Winter Assizes, 1847 (*Reg.* v. *Cawley*), the prisoner was charged with having caused the death of his wife by kicking her in the lower part of the abdomen. Copious bleeding followed, and in spite of medical assistance the woman died very shortly afterwards, evidently from exhaustion produced by the loss of blood. It was stated in evidence that there was no external laceration, but an examination of the body showed that a contused wound (of the genitals) had been produced *internally*,

and had given rise to fatal bleeding. There is nothing at all remarkable in such a result, considering the great vascularity, *i.e.* the abundance of small blood-vessels, in these parts of a woman.

Ecchymosis from violence.—Contusions and contused wounds are commonly accompanied by a discoloration of the surrounding skin, to which the term ecchymosis (ἐκχύω, to pour out) is applied. The subject of ecchymosis is of considerable importance in legal medicine, since it has often given rise to medical difficulties and complicated questions. It consists essentially in the effusion of blood generally from small ruptured vessels, into the surrounding cellular membrane beneath the skin. An ecchymosis is commonly superficial, affecting only the layers of the skin, and showing itself externally, either immediately or in the course of a short time, in the form of a deep blue or livid red patch. According to Dr. Chowne, the former colour is met with in the ecchymosis slowly produced; while that which is the immediate result of violence is red or livid red. In some instances the ecchymosis is deep-seated, the blood being poured out among the muscles and beneath the membranes enclosing them: its extent cannot then be so readily determined by the amount of external discoloration, for this is commonly slight, and it may appear only after the lapse of some hours, or even two or three days. Sometimes the ecchymosis shows itself not over the immediate seat of injury or around it, but at some distance from it. Dr. Chowne met with an instance in which a young man received a severe bruise on the inner ankle. In two days, ecchymosis appeared around the outer ankle. When blood has once escaped from the small vessels, it will sooner or later diffuse itself where it meets with the least resistance, and the layers of skin in the part struck may become so condensed by the blow, that the blood is diffused in the cellular membrane of the adjoining parts. The late Mr. Syme met with a case in which a compound fracture of the tibia about one-third down, was produced by the wheel of a carriage passing over the leg of a woman. There was no ecchymosis around the seat of injury, but after some days, the skin of the knee and lower part of the thigh became discoloured. ('Ed. Med. and Surg. Jour.' Oct. 1836.) Ecchymosis may sometimes proceed from causes irrespective of the direct application of violence to the skin. Strong muscular exertions, the act of vomiting, and many other conditions, may give rise to a rupture of the minute vessels, and to an effusion of blood in parts which have been stretched or compressed. I have known it to be produced to a great extent around the knee (without any blow), from the stretching of the ligament of the kneepan in a person who was trying to save himself from suddenly falling forwards with his knee bent under him. Such cases are commonly recognized by there being no mark of mechanical injury about the part; the skin is smooth and unabraded.

Ecchymosis strictly signifies an effusion or a pouring out of blood; but the effusion may be so deep-seated as not to present any external discoloration (ecchymosis). It is scarcely necessary to observe that the term *effusion* applies to internal as well as to external hæmorrhage, and unless this is borne in mind medical testimony may be wholly misunderstood. Sir R. Christison states that some years ago, on a trial in the High Court of Justiciary at Edinburgh, the public prosecutor attempted to prove that the person assailed had been wounded to the *effusion* of blood, which, according to the law of Scotland, is an aggravation of guilt in such cases. When the principal medical witness was examined as to the injuries inflicted, he was asked whether any blood had been effused; and he replied that a great deal must have been effused. But he meant effusion of blood under the skin, constituting the contusion or bruise described, while the Court at first received the answer as implying that there had been a considerable loss of blood from a wound externally. The ambiguity was, however, detected. ('Edinburgh Monthly Journal,' Nov. 1851, p. 454.) This

case shows the importance of medical evidence being given in language intelligible to all. At the same time the amount of personal injury inflicted is not at all dependent on the external effusion of blood. The assault may be of a most serious kind, and yet no blood be effused through a wound in the skin.

Violence inflicted on a living body may not show itself under the form of ecchymosis until *after death*. A case of this kind was communicated to me by Mr. J. Steavenson. A man received several kicks on the lower part of the abdomen, which caused a rupture of the bladder, and death by peritonitis. He died in about thirty-five hours; but there was no ecchymosis in the seat of the blows, *i.e.* in the pubic and lumbar regions, until after death. Dr. Hinze met with a case of suicidal hanging, in which it was observed that ecchymosis appeared in the course of the cord only after death. (See 'HANGING.') A medical jurist must therefore guard against the error of supposing that when a blow has been inflicted on a living person, it is necessary that the person who is maltreated should survive for a long period in order that ecchymosis should be produced. These facts simply prove that the cause producing the ecchymosis may operate during life, but there may be no appearance of it until after death. This disposes of a popular error that ecchymosis can only be produced in the living body, as well as of the theory that unless a person survives for some time after being subjected to severe blows no ecchymosis will be found on the body. Among numerous cases proving that this statement is not in accordance with facts may be mentioned that of the *Duchess de Praslin*, Aug. 1847. This lady, who was assassinated by her husband, was attacked while asleep in bed. The number of wounds on her person (thirty) showed that there had been great resistance, but the struggle from first to last could not have lasted more than *half an hour*. Yet, on inspection, there were the marks of numerous ecchymoses, which had resulted from the violent use of a bruising instrument. ('Ann. d'Hyg.' 1847, t. 2, p. 377.) The late Prof. Casper of Berlin considered that ecchymosis required a certain time for its production, and that if a person died speedily from the effects of violence, no ecchymosis would be found on the body, although the violence might have been of a bruising nature. ('Handbuch der Ger. Med.' vol. 1, p. 121.) The case of the Duchess de Praslin shows that this is not correct, and Casper himself has admitted that ecchymosis may be produced as the result of violence applied to a recently dead body (see 'STRANGULATION'), a result which is in accordance with other facts mentioned above. If ecchymosis can be produced by violence to the recently dead body, it is clear that a continuance of life is not necessary for its production. The following case shows how these facts may be misapplied. In June 1870, a young man was seen to strike one of his companions. The person struck died suddenly. On a post-mortem examination the mark of a bruise was seen over the sixth and seventh ribs on the right side. About a fortnight before this blow was struck, the deceased had met with an accident: a heavy box fell on his right side, knocked him senseless, and nearly killed him. The question at issue, according to Dr. Guppy of Falmouth who reports this case, was, whether the ecchymosed mark on the side was owing to the blow struck shortly before the man died, or to the fall of the box upon his body a fortnight previously. It was suggested, on the authority of Casper, that as the man died soon after the blow was struck, the ecchymosis could not have arisen from the blow, but that it was most probably due to the fall of the box a fortnight before. ('Lancet,' 1870, 2, 35.) Such a case does not present much difficulty. If the ecchymosed mark was blue or livid, and without any marginal colours, it was probably the result of the blow struck just before death. If the blood is fluid at the time of the violence, and the small capillary vessels are torn through, a blow may cause effusion and the production of an ecchymosis on the skin. The warm liquid

blood thus effused will find its way into the cellular tissue, and produce the usual external appearance. If, in the case quoted, the ecchymosis had been produced a fortnight before, it would have shown some changes of colour at the margin, as described in the next paragraph.

Changes of colour in ecchymosis.—The changes which take place in the colour of an ecchymosed spot are worthy of attention, since they will serve to aid the witness in giving an opinion on the probable time at which a contusion has been inflicted. After a certain period, commonly in eighteen or twenty-four hours, the blue or livid margin of the spot is observed to become lighter; it acquires a violet tint, and before its final disappearance it passes successively through shades of a green, yellow, and lemon colour. During this time the spot is much increased in extent, but the central portion of the ecchymosis which received the violence, is always darker than the circumference. These changes have been referred by Chaussier and others to the gradual dilution of the serous portion of the effused blood by the fluid of the cellular membrane, and its slow and uniform dispersion throughout the cells. The colour is finally entirely removed by the absorption of the blood. The extent and situation of the ecchymosis, the degree of violence by which it has been produced, as well as the age and state of health of the person, are so many circumstances which may influence the progress of these changes. Thus an ecchymosis is longer in disappearing in the old than in the young. Mr. Watson, of Edinburgh, found effused blood in an ecchymosis in an old person, five weeks after the infliction of the injury. Where the cellular membrane is dense, the ecchymosis, *cæteris paribus*, is not so rapidly formed; nor, when formed, do the above changes take place in it so speedily as when the blood is effused into a loose portion of membrane like that surrounding the eye or existing in the scrotum. In some instances an ecchymosis has been observed to disappear without undergoing changes of colour at its margin. On examining an ecchymosed portion of skin which has suffered from a severe contusion, we find that the discoloration affects more or less the whole substance of the true skin, as well as the cellular membrane beneath it.

Evidence from the form of an ecchymosis.—It not unfrequently happens that the ecchymosis produced by a contusion will assume a form indicative of the means by which the violence was offered. In hanging, the impression caused by the cord on the neck is sometimes ecchymosed, and indicates its course with precision; so also in strangulation, when the fingers have been violently applied to the fore part of the neck, the indentations produced may serve to point out the manner in which life was destroyed. A case is mentioned by Starkie, which shows that the form of an ecchymosis may occasionally furnish presumptive evidence against an accused party. In an attempt at murder, the prosecutor, in his own defence, struck the assailant violently in the face with the key of the house-door, this being the only weapon he had near at hand. The ecchymosis which followed this contusion corresponded in the impression produced on the face to the wards of the key; and it was chiefly through this very singular and unexpected source of evidence, that the assailant was afterwards identified and brought to trial. ('Law of Evidence,' vol. 1, art. Cir. Ev.)

Contusions on the dead.—For our knowledge of the effects of *contusions* on the recently *dead* body, we are chiefly indebted to Sir R. Christison. This gentleman found that blows inflicted on a dead body not more than *two hours* after death, gave rise to appearances on the skin similar to those which resulted from blows inflicted on a person recently before death. The livid discoloration thus produced generally arose from an effusion of the thinnest possible layer of the fluid part of the blood on the outer surface of the true skin, but sometimes also from an effusion of blood into a perceptible stratum of the true skin itself. He likewise found that dark fluid blood might even be effused into the subcu-

taneous cellular tissue in the seat of the discolorations, so as to blacken or redden the membranous partitions of the cells containing the fat; but this last effusion was never extensive. From this, then, it follows, that by trusting to external appearance only, contusions made soon after death may be easily confounded with those which have been produced by violence shortly before death.

If a contusion has been caused some hours before death, there will be swelling of the part, and probably also certain changes of colour in the ecchymosed patch, in either of which cases there will be no difficulty in forming an opinion. Although ecchymosis, or an appearance analogous to it, may be produced on a body after death, the changes in colour are then met with only under peculiar circumstances, to be presently mentioned. If the blood found beneath an ecchymosed spot is in a state of coagulum (clotted), this will afford a presumption of its having been effused during life, although, strictly speaking, it only proves that the effusion must have taken place either before death, or very soon after it. The experiments related, in speaking of incised wounds, show that blood effused from a wound ten minutes after death, may be found in a coagulated state. Again, the circumstance of the blood effused under a contused wound being *liquid*, is not a proof that the effusion took place after death; for sometimes, as in death from a sudden and violent shock to the nervous system, or in cases of rupture of the heart, the effused blood does not coagulate. Blood effused into the spinal canal during life is often fluid, and it is well known that blood may be found coagulated in some parts of the body, while it remains fluid in others. There is reason to believe that the blood coagulates more slowly in the dead body than in a vessel into which it has been drawn during life or after death. The blood may remain fluid in a dead body from four to eight, and, according to Donné, as long as twelve hours after death. ('Cours de Microscopie,' 52.) It rarely begins to coagulate until after the lapse of four hours; but if drawn from a blood-vessel and exposed to air, it would coagulate in a few minutes after its removal. (See p. 64.)

In general, contusions which have been produced during life, and in which the effused blood remains liquid, may be recognized by the *extent* of the effusion. If, under the ecchymosed parts, we find a large quantity of liquid blood, and the seat of injury is so situated that the blood could not have become infiltrated into it, and at the same time there is no ruptured vein from which it might have flowed, we may confidently pronounce that the effusion must have preceded death. In a dead body, a contusion would cause but little extravasation, unless a vein of large size had been torn through. The sign which is most satisfactory as a criterion, in the opinion of Sir R. Christison is, however, the following:—In a contusion inflicted during life, the ecchymosed portion of cutis (true skin) is generally dark and much discoloured by the infiltration of blood throughout its whole thickness; the skin at the same time is increased in firmness and tenacity. This is not, however, a uniform consequence of a contusion during life; for a blow may cause effusion of blood beneath the skin without affecting the cutis in the manner stated. The state of the skin here described, cannot be produced by a contusion on a dead body; although it is still an open question, whether it might not be produced if the contusion were inflicted a few minutes after death. As it is, the value of this sign is somewhat circumscribed,—it is not always produced on the living,—it might be possibly produced on the recently dead; so that when it does not exist, we must look for other differential marks, and when it does exist, we ought to satisfy ourselves that the contusion was not inflicted recently after death.

The period at which such injuries cease to resemble each other has not been fixed with any degree of precision; but, as in the case of incised wounds, it would seem that there is little danger of confounding them, when a contusion

has not been inflicted on a *dead* body until after the disappearance of animal heat and the commencement of cadaveric rigidity. Sir R. Christison found that sometimes the appearance of contusions could hardly be produced on a dead body two hours after death; on other occasions they might be slightly caused after three hours and a quarter, but this period was near the extreme limit. Whenever the warmth of the body and the laxity of the muscles are not considerable at the time the blow is inflicted, the appearance of contusions during life cannot be distinctly produced. It is, therefore, only on the trunk that, even in the most favourable state of the body—namely, when warmth is retained and the blood remains altogether liquid—that a mark resembling a contusion on the living body can be produced so late as *two hours* after death. ('Ed. Med. and Surg. Jour.' No. 99, p. 247 *et seq.*) Notwithstanding these satisfactory results, it will be seen that, (from the moment of death until after a lapse of two hours, contusions may be followed by appearances on the dead almost identical with those observed on the living.) The *earliest period* after death in which an experiment was tried on the human body was *one hour and three quarters*: in this case the similarity was so strong that we may infer, if the experiments had been performed within half an hour, or even an hour after death, it would have been difficult to say whether the blow producing the discoloration had been inflicted on a living or dead body. Sir R. Christison's experiments lead to the conclusion that *severe* blows inflicted on a recently dead body produce no greater degree of ecchymosis or cutaneous discoloration than *slight* blows inflicted on the living. Assuming that the great extent of an ecchymosis would in all cases serve to show that the violence which produced it had been inflicted during life, it must be remembered that the importance of these facts in relation to medical evidence, is not affected by the extent of the discoloration. It may be just as necessary to have a positive opinion on the origin of a *slight*, as on the origin of an *extensive* bruise. Slight ecchymoses, as in cases of strangulation or suffocation, if they can be certainly pronounced vital, may make all the difference between the acquittal and conviction of a person charged with murder. Again, slight ecchymosis on the bodies of the drowned may excite a suspicion of strangulation and subsequent immersion of the body in water. So in reference to child-murder. An infant may be destroyed by violence, and only a few slight marks of ecchymosis found upon its body. Irrespective of the *extent* of an ecchymosis, the great point for a medical witness to consider is, whether it occurred during life or after death. Cases in which a mistake might easily have arisen will be related in speaking of marks of violence on the drowned.

The practical inference, then, is, that these discolorations of the skin caused after death, are liable to be mistaken for marks of violence on the living body. An instance has been communicated to me, in which, for the sake of experiment, blows with a stick were inflicted on the recently dead body of a woman while still warm. The body was afterwards accidentally seen by non-professional persons, who were not aware of the performance of these experiments; and so strong was the impression from the appearances, that the deceased had been maltreated during life, that a judicial inquiry was actually instituted, when the circumstances were satisfactorily explained. The fact, therefore, that severe blows after death resemble slight blows during life, is, in a practical view, unimportant. It does not aid our diagnosis, nor prevent serious mistakes from occurring.

Ecchymosis from natural causes in the living.—There are certain conditions of the living body in which ecchymosed marks are found on the skin. A medical witness must be careful not to confound these marks with ecchymosis arising from violence. First with regard to the living body—in aged persons, it is not unusual to find the legs and feet covered with livid patches, sometimes

of considerable uniformity of colour, and at others much mottled. These discolorations, which, after death, might be mistaken for ecchymosis from violence, arise from the languor of the capillary circulation in such persons: the blood with difficulty finds its way through the venous capillaries, and the marks are commonly observed on the lower parts of the body, because they are far removed from the centre of circulation, and the blood has to rise contrary to gravitation. This is the condition which has been denominated by Andral, asthenic hyperæmia. (Andral, 'Anat. Pathol.' t. 1, p. 40.) Similar discolorations are sometimes met with on the bodies of those who have died from scurvy, typhus, and other adynamic diseases. In persons severely affected with scurvy, it is well known that the slightest pressure on any part of the skin will suffice to produce a spot resembling the ecchymosis of violence, and arising like it from a rupture of minute cutaneous vessels; but the effusion of blood, which causes the discoloration, is commonly confined to the superficial layers of the true skin. These patches, under certain states of the system, occur spontaneously, and often cover the body to a great extent: when small, they take the name of *petechiæ*, but when extensive, in which case they bear some resemblance to the ecchymosis of violence, they constitute the pathognomonic character of the disease termed *purpura*. To all these effusions of blood in the living body, the term *Sugillation* (*sugillatio*, a black mark) has been applied. Some medical jurists have attempted to draw a distinction between ecchymosis and sugillation: thus it is said, ecchymosis proceeds from external, sugillation from internal, causes; ecchymosis is confined to the marks which occur in the living body, sugillation to those which occur in the dead:—in ecchymosis the vessels are ruptured, in sugillation there is mere congestion; again, some have considered that ecchymosis and sugillation might take place both in the living and the dead. (Henke, 'Zeitschrift der S. A.' vol. 1, p. 199, and 'Ann. d'Hyg.' 1838, 2, 383.) From this statement, it appears impossible to give a consistent definition of the meaning of either of these terms: but it is altogether unnecessary to make the attempt, for the error, after all, consists in the introduction of a superfluity of words to express a simple condition of the body, depending on different causes. Why, according to the view taken by Chaussier, an ecchymosis should not also be called a sugillation, it is difficult to say: for the definitions above given create no real distinction. I would advise a medical jurist to avoid the use of the term sugillation, if by employing it he considers that he is speaking of a condition essentially different from ecchymosis. It may be occasionally necessary to distinguish ecchymoses in the living body arising from infirmity or disease, from those which have their origin in violence. In regard to the spots or patches on the legs of old persons, their great extent, enveloping as they often do the whole circumference of a leg, is sufficient to establish a clear distinction. In distinguishing the patches of *purpura*, a difficulty may sometimes exist, but here also the appearance of the subject, the general diffusion of them over the whole of the body, and their simultaneous existence on the mucous membrane of the throat and alimentary canal, cannot fail to point out that they originate in some other cause than violence. In the living, these spots have been observed to undergo the same changes of colour as the true ecchymosis of violence. It has been alleged, on the authority of Zacchias, one of the early writers on medical jurisprudence, that a distinction is obtained in these cases after death by a dissection of the part. According to this authority, in what is termed sugillation, *i.e.* the ecchymosis of disease, the blood is fluid, while in the ecchymosis of violence it is described as being in a thick and concrete state. In the remarks already made respecting contusions, facts have been mentioned which show that such a distinction is inadmissible; neither the state of the blood nor its situation will alone suffice to determine the question. Although it has been usual to describe the ecchy-

mosis of disease as being due to a superficial extravasation on the true skin, yet certain cases recorded by pathologists prove that in purpura or scurvy, the discoloration may occasionally extend through the whole substance of the skin to the fatty tissue beneath.

Ecchymosis in the dead body. Lividity.—Ecchymosis may present itself in various forms on the skin of a dead body. The first form when it occurs, is almost an immediate consequence of death, but it is not fully developed until the body has cooled. It is commonly called *cadaveric lividity*. It presents itself in diffused patches of great extent, sometimes covering the whole of the fore part of the chest and abdomen, at other times the lateral regions of the back. The upper or lower limbs, either on their internal or external surfaces, or on their whole circumference, are often thus completely ecchymosed. The appearance is wholly unlike the effects of external violence. Ecchymosis may be a result of putrefaction from the fluid blood escaping from a vessel. Effusions of blood beneath the skin from causes operating after death may produce appearances like those caused by violence, and in certain exceptional cases zones of colour somewhat resembling those of a disappearing ecchymosis may be produced. (See page 91).

Is Ecchymosis a necessary result of violence?—This medico-legal question has often created great difficulty to medical witnesses. It has been repeatedly asserted in Courts of law, that no severe blow could have been inflicted on the body of a person found dead, in consequence of the absence of ecchymosis or other indication of violence from the part struck; but this assertion is entirely opposed to well-ascertained facts. However true the statement may be that severe contusions are commonly followed by ecchymosis, it is open to numerous exceptions; and unless these are known to a practitioner, his evidence may mislead the Court. The presence of ecchymosis is commonly presumptive evidence of the infliction of violence, but its absence does not negative this presumption.

It was long since remarked by Portal, that the spleen had been found ruptured from blows or falls, without any ecchymosis or abrasion of the skin appearing in the region struck. This has been also observed in respect to ruptures of the stomach, intestines, and urinary bladder, from violence directly applied to the abdomen. Portal supposed that the mechanical impulse was simply transferred through the supple parietes (or skin) of the abdomen to the viscera behind, as in the striking of a bladder filled with water. Whether this be the true explanation or not, it is quite certain that the small vessels of the skin often escape rupture from a sudden blow, so that their contents are not effused. Casper thought that under these severe injuries the non-production of ecchymosis in the skin was to be ascribed to the loss of blood from the ruptured liver or other organ ('Handbuch der Ger. Med.' 1, 121), but this explanation will not account for the facts. In some of the cases the part ruptured has been the intestines or the urinary bladder, from which a large quantity of blood would not flow. A case is reported by Henke, in which a labouring man died some hours after fighting with another, and on an inspection of the body the peritoneum was found extensively inflamed, owing to an escape of the contents of the small intestines, which had been ruptured to a considerable extent. There was, however, no ecchymosis or mark on the skin externally, and the medical inspectors were inclined to affirm, contrary in this case to direct evidence, that no blow could have been struck; but others of greater experience were appealed to, who at once admitted that the laceration of the intestines might have been caused by a blow, even although there was no appearance of a bruise externally. Mr. Watson states that a girl, aged nine, received a smart blow upon the abdomen from a stone. She immediately complained of great pain; collapse ensued, and she died in twenty-one hours.

On inspection there was no mark of injury externally, but the ileum (one of the small intestines) was found ruptured, its contents extravasated, and the peritoneum extensively inflamed. ('On Homicide,' p. 187.) Dr. Williamson, of Leith, met with a case in which a man received a kick on the abdomen from a horse: he died in thirty hours from peritonitis. The ileum was found to have been torn completely across in its lower third. There was not the slightest trace of ecchymosis externally, a fact which is the more remarkable, since the blow was here struck by a somewhat angular or pointed body—the hoof of a horse. ('Med. Gaz.' May 1840.) In a fatal railway accident which occurred at Leicester in November 1854, there were no marks of external violence on the head, but Mr. Macaulay found a laceration of the left hemisphere of the brain, with effusion of a large quantity of blood which had coagulated.

Many cases might be adduced in support of the statement that ecchymosis is not a necessary or constant result of a severe blow or mechanical violence; but those above related sufficiently establish the fact. (See 'Ruptures of the Heart, Liver, Spleen, and Kidneys,' post.) This medico-legal question frequently arises in cases in which the bladder or liver is ruptured, as, owing to the general absence of marks of violence, it is often alleged in defence that no blow or kick could have been inflicted on this part of the abdomen. The incorrectness of this view will be apparent by a reference to cases of ruptured bladder related in another part of this work. I am indebted to the late Dr. Easton of Glasgow, for a case of rupture of the liver, under circumstances in which ecchymosis would have been generally expected to take place as a result of violence. In January 1852, a woman, aged seventy-five, was run down by a cab in the streets of Glasgow, and died in less than half an hour. No ecchymosis existed, although four ribs on the right side of the chest at the lower part were broken, and the liver was ruptured in two places longitudinally, and throughout the entire length of its anterior and convex surface. The laceration of this organ had not been caused by the fractured ends of the ribs penetrating downwards, for of these there was no displacement, but the organ seemed to have burst in consequence of the heavy compression to which it had been subjected, which had not, however, been sufficient to occasion any discoloration of the skin externally. The following case was tried before the Justiciary Court of Glasgow, in January 1837. A woman was found dead in her house, and her husband was accused of having murdered her. There was no mark of violence externally; but on opening the abdomen, the liver was found extensively lacerated, and there was no doubt that this was the cause of death. A medical witness asserted, that as there was no appearance of injury externally, the rupture could not have been caused by a fall or a blow. He attributed the absence of marks of ecchymosis to the rupture having been occasioned by the forcible pressure of some heavy rounded smooth body on the abdomen. The prisoner was acquitted on a verdict of not proven. The liver is seldom ruptured except from violence directly applied, and it is observed that the rupture is more commonly caused by a *sudden* than by a slow application of violence. It may have been ruptured in this case either by a blow or a fall—the absence of ecchymosis in the skin of the abdomen is consistent with either view. The explanation given by the witness would neither account for the rupture nor for the absence of ecchymosis; for these conditions are more commonly met with under directly opposite circumstances. At the same time, in cases where the facts are imperfectly known, a surgeon must not be too ready to assume, in the absence of ecchymosis or injury to the skin, that violence has been directly applied and has caused the rupture of an internal organ. That murderous violence may be produced by blows on a body without leaving any external marks, is further proved by a case tried in Scotland (*Cuming* for the murder of his wife, Dec. 19th, 1853). The woman

died from a severe injury to the head, but she chiefly complained of great pain in one of her breasts, and in her chest on that side. From her statement it appeared that the prisoner had used great violence to this part of her body; yet on a careful examination, during life and after death, there were no marks of ecchymosis or contusion. The case of *Slater and Vivian* (Central Crim. Court, Sept. 1860), charged with the manslaughter of a lunatic at Colney Hatch Asylum, presents many points of importance in reference to this medico-legal question. (Winslow's 'Med. Critic, and Psychological Journal,' No. 1, Jan. 7, 1861, p. 91.)

CHAPTER 35.

EVIDENCE OF THE USE OF A WEAPON—CHARACTERS OF WOUNDS CAUSED BY WEAPONS—INCISED, PUNCTURED, LACERATED, AND CONTUSED WOUNDS—STABS AND CUTS—WHAT ARE WEAPONS?—EXAMINATION OF THE DRESS—WOUNDS PRODUCED THROUGH THE DRESS.

Evidence of the use of a weapon.—It is not necessary to prove that a weapon has been used for the production of a wound, for the words of the statute are:—'Whosoever shall, *by any means whatsoever*, wound or cause any grievous bodily harm to a person,' &c.; yet evidence of the use of a weapon in cases of assault may materially affect the amount of punishment awarded on conviction. When, upon the clearest evidence, it is certain that a weapon has been used, it is not unusual for prisoners to declare that no weapon was employed by them, but that the wound had been occasioned by accidental circumstances. A witness should remember that he is seldom in a position to swear that a particular weapon produced at a trial must have been used by the prisoner:—he is only justified in saying, that the wound was caused either by it or by one similar to it. Schwörer relates the following case. A man was stabbed by another in the face, and a knife with the blade entire was brought forward as circumstantial evidence against him, the surgeon having stated that the wound had been caused by *this* knife. The wounded person recovered; but a year afterwards an abscess formed in his face, and the broken point of the real weapon was discharged from it. The wound could not therefore have been produced by the knife which was brought forward as evidence against the prisoner at the trial. ('Lehre von dem Kindermorde.') Although the criminality of an act is not lessened or impugned by an occurrence of this kind, it is advisable that such mistakes should be avoided by the use of proper caution on the part of a witness. On this question, see the case of *Renaud*, by Dr. Boys de Loury, 'Ann. d'Hyg.' 1839, 2, 170. As to what is a weapon, see Henke, 'Zeitschrift der S. A.' 1844, 1, 67.

Characters of wounds produced by weapons.—Let us now suppose that no weapon is discovered, and that the opinion of a witness is to be founded only on an examination of the wound. It is right for him to know that on all criminal trials considerable importance is attached by the law to the fact of a wound having been caused by the use of a weapon; since this generally implies malice, and in most cases a greater desire to injure the party assailed than the mere employment of manual force. Some wounds, such as cuts and stabs, at once indicate that they must have been produced by weapons.

1. *Incised wounds.*—In incised wounds, the sharpness of the instrument may be inferred from the cleanness and regularity with which the edges are cut: in stabs, also, the form and depth of a wound will often indicate the kind of weapon employed. Stabs sometimes have the characters of incised punctures, one or both extremities of the wound being cleanly cut, according to whether the weapon was single or double-edged. Dupuytren has remarked that such

stabs, owing to the elasticity of the skin, are apparently smaller than the weapon —a point to be remembered in instituting a comparison between the size of a wound and the instrument. A lateral motion of the weapon may, however, cause a considerable enlargement of the wound. (See case, 'Ann. d'Hyg.' 1847, 1, 400.) When a stab has traversed the body, the entrance-aperture is commonly larger than the aperture of exit; and its edges, contrary to what might be supposed, are sometimes everted, owing to the rapid withdrawal of the instrument. That facts of this kind should be available as evidence, it is necessary that the body should be seen soon after the infliction of a wound, and before there has been any interference with it.

2. *Punctured wounds.*—It is necessary to notice whether the edges of a punctured wound are lacerated and irregular, or incised; because it may be alleged in defence, that the wound was produced by a fall on some substance capable of causing an injury somewhat resembling it. In a case that occurred to Mr. Watson, a deeply penetrating wound on the genital organs of a woman, which had evidently caused her death, was ascribed by the prisoners charged with the murder to her having fallen on some broken glass; but it was proved that the edges of the wound were bounded everywhere by clean incisions, which rendered this defence inconsistent if not impossible. I have known a similar defence made on two other occasions, where the cases came to trial. In one, a man struck the prosecutor, and knocked him against a window. On examination, there were three deep cuts on the face of the prosecutor, but no weapon had been seen in the hands of the prisoner. He was charged with cutting and stabbing. The surgeon deposed that the wounds appeared to have been inflicted with a knife or razor-blade, and not with broken glass. If the wounds had been made with glass, particles of that substance would probably have been found in them, but there were none. The prisoner was acquitted, the infliction of the wounds by a weapon not being considered to have been sufficiently made out. In another case that occurred in August 1841, the prosecutor was knocked down, and his throat was found severely cut, but there was no direct proof that a weapon had been used. In the defence it was urged that the wound had been produced by a broken pane of glass, but the surgeon described it as a clean cut, five inches in length and one inch in depth, laying bare the carotid artery. He considered that it must have been inflicted by a razor or knife, and that it was a cut made by one stroke of the instrument. In *Reg.* v. *Ankers* (Warwick Lent Assizes, 1845), a clean cut as from a penknife, about two inches long and one deep, was proved to have existed on the person of the prosecutor, who had fallen during a quarrel with the prisoner. Some broken crockery was lying near the spot, and it was alleged in the defence that a fall upon this had caused the wound. This allegation was quite inconsistent with the clean and even appearance of the edges of the wound. The prisoner, in whose possession a penknife had been found, was convicted.

In general, wounds made by *glass or earthenware* are characterized by their great irregularity and the unevenness of their edges. Cases of this kind show that, as it is not always possible to know when this sort of defence may be raised, a medical witness should never fail to make a minute examination of a wound which is suspected to have been criminally inflicted. A trial for murder took place at the Worcester Summer Assizes, in 1838, in which it appeared in evidence that the deceased had died from a small punctured wound in the chest. It was five inches and a half deep; it had completely traversed the right ventricle of the heart, and had led to death by loss of blood. The wound was supposed to have been produced by a small skewer, which was found near the spot, but in the defence it was alleged that the deceased had fallen over a tub, and that the wound had been caused by a projecting nail.

This allegation, however, was negatived by the surgeon, from the fact of its being a cleanly *cut* wound. Had it been produced in the manner alleged by the prisoners, this would have been indicated by an irregularity of margin. In the case of *Bryant* (Taunton Lent Assizes, 1849), which involved a charge of maliciously stabbing the prosecutor, the defence was that many flints were lying about in the road, and as the assault took place in the dark the wound might have been inflicted accidentally during a fall. The medical witness could not say that the wounds had been positively caused by a weapon: they might have been produced by the flints. The prisoner was acquitted, as the statute then required proof that a wound had been inflicted by some instrument. A careful examination made at the time of the injury would most probably have enabled the witness to give a decided opinion, instead of leaving the case open to doubt. A puncture made by a flint during a fall is not likely to resemble a stab with a knife. The wound would present some marks of laceration and great irregularity. As the wound was under the ear, it was by no means probable, from the situation, that it could have been thus caused accidentally. A similar question has recently arisen in a case in which the prisoner was charged with inflicting a wound with a knife. In the defence it was urged that the wound was caused by the sharp edge of an oyster-shell. A careful examination made when a wounded person is first seen would enable a medical man to meet suggestions of this kind, which are often thrown out unexpectedly in the defence. The answer to such a question may materially affect the amount of punishment inflicted on the prisoner, as the use of knives or daggers is not looked on with the same leniency in this country as it is in Spain and Italy.

These medical difficulties are now for the most part removed by the 24th and 25th Victoria, Chapter 100. This must not, however, lead the witness to suppose that a personal injury is not to be carefully examined with a view to the determination of this question. In January 1853, Mr. Hancock was enabled, by the careful examination of a wound, to disprove a charge of maliciously wounding made against innocent persons. A little girl was represented to have received, while sitting over an iron grating, a wound in the pudendum, by some persons pushing a toasting-fork or pointed instrument between the bars of the grating from below. There were no marks of punctures, which would have been found had this statement been true, but a slight laceration of the parts, such as might have been produced by an accidental fall on the edge of the iron grating while the girl was in a sitting position. There were also marks of bruises on the thigh, such as might have occurred from an accident of this kind. The mother of the child had made a false charge for the sake of exciting public compassion and extorting money. A proper surgical examination of the injury clearly established that it had resulted from accident. The part of the body in which the injury existed in this case, is not usually exposed to laceration or punctures from accident; but the child, for a certain purpose, had placed herself voluntarily in this position, and had on her own admission slipped, and thus probably injured herself.

3. *Lacerated and Contused wounds.*—Lacerated wounds do not in general present greater difficulty with regard to their origin than those which are incised or punctured. The means which produced the laceration are commonly well indicated by the appearance of the wound. These injuries are generally the result of accident; they are, however, frequently met with on the bodies of new-born children, in which case they may give rise to a charge of infanticide. If it could be proved that they had arisen from the use of a weapon, this would, of course, go far to a conviction on a charge of murder. *Contused* wounds and severe contusions present much greater diffiulty to a medical jurist. It is not often in his power to say whether a contused wound has resulted from

the use of a weapon, from *a blow of the fist*, or *a fall*, by reason of the deceased having accidentally fallen against some hard surface. The question is frequently put to medical witnesses, on those trials for manslaughter which arise out of the pugilistic combats of half-drunken men. One of the combatants is generally killed, either by a blow on the head, by a fall, or by both kinds of violence combined. The skull may or may not be fractured; and the person may die of concussion, inflammation of the brain, or from effusion of blood. The general defence is that the deceased struck his head against some hard substance in falling on the ground, and a surgeon is asked whether the particular appearances might not be explained on the supposition of a fall. A medical witness is rarely in a position to swear with certainty that a contused wound of the head must have been produced by a weapon and *not* by a fall. Some circumstances, however, may occasionally enable him to form an opinion on this point. If there are contused wounds on several parts of the head, with copious effusion of blood beneath the skin, the presumption is that a weapon must have been used. If the marks of violence are on the summit of the head, it is highly probable that they have been caused by a weapon, since this is not commonly a part which can receive injury from a fall. So if sand, gravel, grass or other substances be found in a contused wound, this will render it highly probable that the injury was really caused by a fall. When the question is simply whether a contused wound was produced by a blow of the fist or by a weapon, it may admit of an answer from an examination of the wound, as in the following case, which occurred in August 1871. Two men were fighting and one struck the other a severe blow on the head, felling him to the ground. The deceased was rendered insensible and soon died. There was a fracture of the skull six inches in length. The prisoner alleged that he struck the deceased only with his fist. The medical opinion was that a blow of the fist could not have produced such a severe injury. A weapon must have been used. While full allowance is made for the effect of falls, it must be remembered that there are injuries which from their nature are not likely to have been produced by blows of the fist.

It matters not, under the new statute on wounding, whether the wound was produced directly by a weapon employed by an assailant, or indirectly by any act of violence on his part. A man may fracture the skull of another either by striking him with a brick, or by striking him with his fist and thus causing him to fall against a brick. Acquittals formerly took place upon technicalities of this kind. ('Law Times,' March 21, 1846, p. 501); but in *Reg.* v. *Dodd* (Shrewsbury Summer Assizes, 1853), Coleridge, J., expressed a strong opinion against the distinction thus made. The prisoner, it was alleged, threw a stone at the deceased, who immediately fell on a stone floor. The deceased was able to go about for several days, but he died a week after he had sustained the violence, from inflammation of the brain, as a result of fracture of the skull. The medical witness ascribed the fracture to a blow from a stone. In the defence it was urged that the fracture might just as well have arisen from the fall on a stone floor. Coleridge, J., held, if the prisoner knocked the deceased down, that it would make no difference whether the deceased died from the fall on a stone floor, or from injury directly produced by the stone which was thrown at him.

In *Reg.* v. *Howes* (Croydon Summer Assizes, 1863), the deceased, the wife of the prisoner, was found dead with severe contusions on the head and face, and a lacerated wound on the temple. She died from extravasation of blood on the brain. The defence was that deceased had fallen against a fender, while intoxicated, and so had caused the wounds; but it was properly stated by the witness that, although a lacerated wound on the side of the head might have been so caused, the other injuries bore the characters of repeated blows. The

counsel for the defence wished to make a general amalgamation of all this violence, although the witness had stated that the head, from the temple to the occiput, was one mass of contusions, independently of the bruises met with on the face. Apart from all scientific speculations, no fall upon a fender could possibly account for the *whole* of these injuries, but it was necessary in addition to assume that the woman was continually drunk (of which there was no proof), and that in falling her head and face alone invariably suffered! In reference to the cause of the violence, the learned judge (Channel, B.) remarked—'If there were blows, and by means of blows the prisoner caused the falls, then though the blows might not themselves be the direct cause of death, he would be responsible for the result.' The prisoner was convicted of manslaughter. A similar question arose in *Reg.* v. *Budd* (Kingston Lent Assizes, 1868), where a man was charged with killing his wife by blows. It appeared that he had either kicked her and produced the injury which caused her death, or that she had fallen upon some wood as a result of his violence. Byles, J., said it was not material whether death was caused directly by the blow or kick, or whether the prisoner struck or pushed his wife and she fell so as to produce the injury which caused her death; the prisoner would equally be guilty of manslaughter. He was convicted. If it could be shown that the fall was the result of some accident, then it might be a good ground for defence.

A doubt may occasionally arise whether a *weapon* has or has not been used in reference to lacerated or contused wounds. Contused wounds on bony surfaces, as on the head, sometimes present the appearance of incised wounds, the skin being evenly separated. When a wound is recent, a careful examination will generally enable a witness to form a correct opinion, but if some time has elapsed before a wound is examined, great caution will be required in forming a judgment. The following case was communicated to me by a pupil who gave evidence at the trial of the prisoner. The prosecutor, it was alleged, had been stabbed on the head with a knife. The prisoner struck the blow, and he certainly had a knife in his hand at the time, but whether the wound was or was not produced by the knife could not be determined from the evidence of eyewitnesses. In the defence it was urged that the prisoner had inflicted the wound with his knuckles and not with a knife. When the surgeon was called to examine the wound some time after its infliction, there was so much contusion and laceration about its edges, that it was impossible to ascertain, with the necessary legal precision, by what means it had been caused. There was suspicion, but no medical proof, that a weapon had been employed.

A surgeon should be cautious in listening to the statements of others, that a weapon has been used, unless the wound itself bears about it such characters as to leave the fact indisputable. During a scuffle, the person assaulted may be easily deceived as to the way in which an accused party inflicted a wound upon him; and a bad motive may sometimes exist for imputing to an assailant the use of a weapon during a quarrel. In such cases we should, as medical witnesses, rather trust to the appearance of the wound for proof of the use of a weapon, than to any account given by interested parties. In a case which was tried in 1842 at the Chelmsford Assizes, a surgeon swore that a wound on the nose of the prosecutrix had been produced by a knife, and not by a blow with the fist, as it was alleged in the defence. There seems to have been no good medical reason for the opinion that a knife had been used: it appears to have been founded chiefly on the loose statement of the prosecutrix herself. Nevertheless a conviction followed upon this evidence, and a respectable woman, charged as accessory, was sentenced to a severe punishment, not for having assaulted the prosecutrix, for it does not appear that she struck a blow, but for aiding another in the supposed act of stabbing. It was alleged that she handed a knife to the assailant, when it was extremely doubtful, medically speaking,

whether any knife had been used in the assault. This case appears to me to convey a serious caution in respect to the medico-legal examination of wounds. A medical man is not justified in giving a hasty opinion of a weapon having been employed from mere hearsay; he may, in this way, lead to the infliction of a very severe and unmerited punishment.

A late learned judge suggested to me that some means of discrimination between the effects of falls and blows affecting the same part of the body, would greatly aid the administration of justice. There is no doubt that it would, but as no two cases coming under this class of injuries are precisely alike either in the part wounded or the amount of force employed, it is scarcely possible to introduce general rules or to make statistics practically available. It is commonly supposed that a mere fall is not sufficient to produce the same degree of injury that may be caused by a blunt weapon, applied suddenly to the head by human force; but a severe fracture may arise from a simple accident of this kind, and present nearly all the characters of homicidal violence. (See case, p. 480.) The difficulties at criminal trials will, I think, be found to proceed, not so much from want of rules to assign the violence to one condition or the other, as from a want of proper observation when the wounds are first examined. If minute attention were given to an examination of these injuries soon after their occurrence, circumstances would be noticed which would help the medical witness to a conclusion. The defence that they might have been produced by a fall, is not set up until a subsequent period, and the surgeon is then obliged to trust to his memory for the main points of distinction. Such improvised opinions usually fail in impressing a jury.

The case of *Mr. Briggs*, who was murderously assaulted in a carriage on the North London Railway in July 1864, furnishes an illustration of the ease with which homicidal and accidental violence may be distinguished, provided attention is directed to this question at the time. There were several wounds on the head of this gentleman which could not have proceeded from one cause. It appeared probable that some had been inflicted on the deceased by a heavy blunt instrument while he was in the carriage, and that he had then been thrown from it while the carriage was in rapid motion, and the fall had produced other bruises. The surgeon who examined the deceased found a transverse jagged wound across the left ear, and above this there was a scalp-tumour as well as two distinct wounds of the scalp with effusion of blood beneath and corresponding fractures in the bones. There had obviously been more than one distinct application of force to produce such injuries. The fractures in the skull in two distinct places indicated the use of a heavy blunt weapon, while the scalp-tumour was probably caused by the head coming in contact with the ground at that point. A large stone with some blood and light grey hair resembling that of deceased was found in the road near the spot where the body was lying.

In this case the assassin had no doubt intended that death should appear to be the result of an act of suicide—the fall from a train in motion necessarily producing severe injuries, which might reasonably account for death. An assailant may select his opportunity of inflicting violence upon another while riding on horseback, and by causing him to fall from his horse may thus give the appearance of accidental injuries. A proper medical examination, however, could not fail to reveal the real state of facts. In July 1861, the *Baron de Vidil*, a French nobleman of high social position, was charged with attempting to murder his son, Alfred de Vidil, under the following circumstances. He invited his son, on false pretences, to take a ride on horseback with him—he led him into a solitary lane near Twickenham—fell behind and then suddenly struck his son several severe blows on the head with a heavy riding whip having a metal head. The young man, although severely wounded, was able to

keep his seat, and soon procured assistance. The Baron alleged in defence that his son's horse had shied and had thrown him against a wall. The surgeon who examined the son soon after the occurrence found on the head two contused wounds of a star-shape cutting through the skin to the bone, one at the upper part of the forehead, near where the hair grows, and the other at the back of the head. There were no scratches or other injuries to the face. The medical witness very properly said that these two wounds in different parts of the head were inconsistent with their production by any fall or by such an accident as that assigned by the accused. They had the appearance of having been caused by separate blows from some heavy blunt instrument, the force being concentrated on each point. This medical view of the cause of the injuries was borne out by the direct evidence of an eye-witness who saw the prisoner strike the blows. It was proved that, by the death of his son, the prisoner would have come into the possession of a large sum of money. The Baron was tried at the Central Criminal Court, and although the son refused to be a witness against the father, he was convicted of an assault upon the medical and general evidence.

When it is a question which of two weapons produced certain bruised wounds found on the head, the difficulties of medical evidence are increased. In *Reg.* v. *Teague* (Cornwall Summer Assizes, 1851) the prisoner was charged with the murder of his father-in-law. The deceased was found dead with a large wound in the centre of the forehead. According to the medical evidence, it had the appearance externally of being two, but was in reality only one wound, inflicted by more blows than one. The wound was nearly of a circular figure, with a band of skin passing vertically across it. The bone had been driven in to some depth. A large hammer was found near with white hair upon it, but no blood. It was alleged for the prosecution, that the contused wound had been produced by this hammer by the act of the accused, and it was stated by the medical witness that one end of the hammer corresponded to the shape and other physical characters of the wound. The defence was, that the injury had been caused either by a fall or by a kick from a horse. It was not at all probable that any fall could have produced such a wound, without greatly disfiguring the face, which presented no marks of injury; and in reference to its production by a kick, the witness compared the horse's shoes and found that the wound bore no resemblance whatever to them. One circumstance appeared to connect the hammer with the wound, namely, the presence of some white hairs upon it; but the evidence failed to fix the crime upon the prisoner, since it only went to prove that he had had the opportunity of committing the crime, but there was no apparent motive for its commission. ('Med. Gazette,' 1851, 48, 729.)

In most instances an accurate observation of the form of a contused wound, and an early comparison of it with the supposed weapon or the substance said to have produced it, will enable a witness to come to a correct conclusion on the subject. The situation, depth, and shape of the wound, may be such that no accidental fall could reasonably account for its production. In *Reg.* v. *Skelton* (Carlisle Spring Assizes, 1858) the evidence showed that deceased, an old man, had died from violence to the head. He was found insensible and bleeding in the road, not far from the prisoner's house. An angular stone was lying near to his head. There were no bruises on the body, but on the left side of the crown of the head, the medical inspectors found a square-shaped hole about the size of a half-crown piece, the bone being there driven in. Three inches below this, above the tip of the ear, there was another fracture of the skull under a narrow scalp wound about an inch in length. In the prisoner's house was found a hammer, which had a square face, the corners only rounded off; and on comparing this with the indented wound and fracture, it corresponded very nearly in shape and width. The other end,

when compared with the smaller wound near the ear, also corresponded. The hammer, as it frequently happens with heavy bruising instruments, had no blood upon it, nor anything to indicate that it had been used for inflicting the injuries. The stone found near the deceased had upon it blood and mud at one corner, and a white human hair adhered to it. It was admitted by the medical witnesses that had the deceased fallen heavily upon this stone, it would have accounted for the lesser wound; and with respect to the indented wound, it was suggested that had he been knocked down by a horse and trampled on, the 'caulker,' or square piece of iron at the heel of a horse-shoe, might have produced it. They at the same time properly stated that the other part of the shoe would have left some mark, of which there was no trace. The hat worn by the deceased at the time presented no indentation or mark. It is probable from this description that the injury was produced by a weapon, but the evidence failed to connect the prisoner with the act.

In assaults on women, it is not unusual to find that the complainant herself endeavours to exculpate the assailant by ascribing the marks of violence, not to blows, but to some accidental fall. In August 1864, a woman deposed before a magistrate that certain severe injuries which she had sustained had been caused by her falling on a fender. The medical man who examined her, found on the top of the head three distinct wounds which were bleeding. Two appeared as if they had been caused by a blunt instrument: the third on the back part of the head was a cleanly cut wound. He considered that they had been produced by a chopper, and that none of them had been caused by a fall or a series of falls. The prisoner on this evidence was committed for trial.

4. *Stabs and Cuts.*—It has been remarked that the law in some cases attaches great importance to the clear proof of the use of a *weapon*; and a medical man has therefore a certain responsibility thrown upon him when, in the absence of a weapon and the denial of its use, he is called upon to say whether one has or has not been used. In reference to cuts and stabs there can in general be no difficulty, for these injuries carry with them distinct evidence of their mode of production. Formerly stabbing and cutting were treated as distinct from wounding, and very nice legal distinctions were drawn between these terms, which had the effect of procuring acquittals on mere legal technicalities. Under the new consolidated Act, the words 'stab' and 'cut' are properly omitted, and the word 'wound' only has been retained. Medical men would always agree upon a stab or cut being a wound, but they might reasonably differ upon the question whether in a given case a wound was really a stab or cut. It might be punctured, lacerated, or contused, and not fairly come under the professional description either of a cut or a stab. In the meantime, the only party who derived benefit from this grammatical confusion, was the assailant who had inflicted the undefined injury on another. A medical witness has now only to prove that the personal injury falls strictly within the meaning of the term *wound*: he is not called upon to prove the precise variety of wounding to which the injury should be assigned. At the same time, he should always be prepared for a full description of the characters of an injury in case questions on the subject should be put to him.

What are Weapons?—The new statute has removed those legal doubts which formerly arose in reference to the true signification of the term *weapon*. Thus the teeth, the hands or feet uncovered, were formerly held by the judges *not* to be weapons; and injuries produced by them, however severe, were not treated as wounds within the meaning of the statute. Parties were tried on charges of biting off fingers and noses, and although the medical evidence proved that wounds of a severe kind had been thus inflicted and that great disfigurement and mischief had been done to individuals, yet the nature of the injury produced was not so much regarded as the actual method by which it was accomplished. The persons charged were acquitted under an indictment

for 'wounding,' since wounds in a legal sense could be produced only by weapons, while the teeth, hands, and feet were not weapons in law. On a trial which took place at the Nottingham Assizes in 1832, a strenuous effort was made by prisoner's counsel to claim for artificial arms and legs the same privilege of exemption that was accorded to natural arms and legs. In the case alluded to, it was argued in defence that a wooden arm with an iron-hook at the end of it, with which an assault was committed, had become, by long use, part of the body of the prisoner, and that, like a natural arm, it ought not to be considered a weapon in law! The objection was overruled. Except in so far as the deliberate use of a weapon may indicate an intent to inflict a greater amount of personal injury, such questions as these cannot again arise. It would really seem, however, from a recent case, that the iron-hook may be in the opinion of some judges what the French call an 'extenuating circumstance.' A man named *Benson* was tried for a felonious assault at the Central Criminal Court in November 1871. The evidence showed that the prisoner having no left hand, struck the prosecutor on the face with an iron-hook which served as a substitute, and produced serious injuries. He conducted his own defence, but did not base it on the theory that the iron-hook was a substitute for his natural means of defence. The jury found him guilty. The Deputy-Recorder remarked in sentencing him that 'having the hook screwed to his arm, the assault, though very brutal, was less heinous than if it had been done with a knife procured for the purpose.'

Examination of the dress.—This as a rule is a most important part of the duty of a medical man. In a case of severe wounding, of whatever kind, he should always require to see the dress of the wounded person. It may throw a material light upon the *mode* in which a wound has been produced: it may remove an erroneous suspicion of murder, and may sometimes serve to indicate that a wound has been self-inflicted for the concealment of other crimes, or falsely to impute its infliction to other persons. Marks of blood, dirt, grass, or other substances on the clothing, may also throw a light upon the mode of infliction. So again the use of a weapon, in reference to cuts and stabs, may be inferred from the dress presenting corresponding cuts or perforations. Contused wounds by bludgeons may, however, be readily produced through the dress, without tearing or injuring it. Considerable laceration of the skin and muscles, and even severe fractures, may be caused without necessarily penetrating the dress, supposing it to be at all of an elastic or yielding nature. In self-inflicted or imputed wounds, if of the nature of cuts or stabs, there is often a want of correspondence between the perforations of the dress and the wounds on the person: this is one of the characters by which the correctness of a statement may be tested. (See 'IMPUTED WOUNDS.') A severe wound may be indirectly produced by a bruising weapon, and medical witnesses have been often questioned on this point. Thus, the prosecutor may at the time have worn about his person some article of dress which received the blow, and this may have caused the wound. On a trial for maliciously wounding, which took place at the Reading Spring Assizes in 1837, it appeared in evidence that the prisoner, while poaching, assaulted a gamekeeper by inflicting on his head severe blows with a gun. At the time of the assault, the prosecutor wore a strong felt hat, which, it was contended in defence, had caused the wounds that formed the subject of the charge. The medical witness admitted that the wounds might have been produced either by the gun, or by the hat through a blow from the gun. The prisoner was convicted; this was held to be a wounding, although the gun did not touch the skin. In another case, a blow was struck with a bludgeon at the head of the prosecutor, who wore spectacles. Wounds were produced, which, it was argued in the defence, had resulted from the glass of the spectacles and not from the bludgeon. The prisoner was

acquitted. Every case of this kind must be determined by the circumstances which accompany it. One fact appears to me to be well established from the foregoing cases—namely, that a medical practitioner should always make a careful examination not only of wounds which are likely to become the subject of criminal charges, but of the dress or clothing worn by the wounded person at the time of the assault. In performing his duties as a surgeon, he is bound, so far as he consistently can, to notice as a medical jurist the characters of all personal injuries, so as to be able to give an opinion on the mode in which they were inflicted.

When the question is simply, whether the contused wound resulted from accident or homicide, a careful examination of the dress may tend to remove any medical or legal doubts. A case was tried at the Warwick Spring Assizes in 1808, which not only in this, but in some other points of view, is of great medico-legal interest. In this instance a man was found dead in a stable, not far from a vicious mare, and the traces of this animal were upon his arms and shoulders when the body was discovered. The brother of the deceased was tried on the charge of having killed him with a spade, which was found lying in the stable. This spade was stained with blood, but the evidence from this fact was wholly set aside by the circumstance that the spade had been subsequently used in cleaning out the stable. In the defence it was alleged that the deceased had been kicked by the mare while attempting to put on the traces and had thus been accidentally killed. According to the medical evidence, there were two straight *incised* (?) wounds, apparently caused by a blunt instrument, on the left side of the head, one about five and the other about two inches long. On the right side of the head there were three irregular wounds of a mixed lacerated and incised character, two of them about four inches in length. There was also a wound on the back part of the head, about two inches and a half long. There was no swelling round any of the wounds, the skin adhering firmly to the bone. The right side of the skull was generally fractured—the fracture extending along the back of the head to the left side—a small portion of the temporal bone having come away. The deceased was found with his hat on, which was bruised in the part corresponding to the seat of injury, but not cut; but there were no wounds on any other part of the body. Two medical witnesses expressed a strong opinion that the injuries could not have been produced by kicks from a horse, grounding that opinion principally on the distinctness of the wounds, the absence of marks of contusion, the firm adhesion of the skin, and the straight lateral direction and similarity of the wounds. They also thought that they could not have been inflicted without cutting the hat, if this had been on the deceased's head at the time; and if the hat had been off, that he could not have had the power to put it on after receiving the wounds. The case was not made out against the prisoner, and he was acquitted. (Wills' 'Circ. Evidence,' p. 302.) Taking the medical facts as they are here reported, there seems to have been no good medical reason for assuming that the wounds on the head were homicidally inflicted. The fact that they had a somewhat incised character is not a positive proof that the spade was used in producing them, since an instance has occurred where the skin of the scalp presented a similarly incised appearance from the kick of a horse; and I believe this is not an unusual consequence of a severe and sudden blow on those parts of the body where the elastic skin is stretched over round surfaces of bone. In this case, however, another question arose, namely, whether wounds of this description could be inflicted on the head without necessarily cutting through the hat. Admitting it to be improbable that the deceased could have placed the hat on his head after being thus wounded, we must infer that it was on his head at the time, and assuming that the injury was produced by the bruising violence of a horse's hoof, it is

easy to understand that the scalp might be wounded and the skin broken without causing more than an indentation in the hat. Had the spade been used, it is less probable that the hat would have escaped the effects of violence. Hence the witnesses who assumed that the deceased had been killed by the spade, were obliged to suppose that the hat must have been off, and put on afterwards, therefore that there must have been murderous interference. This, however, would not explain the fact that the hat was indented over the situation of the principal injury. On the whole, this seems to have been really a case of accidental violence, this theory being strongly supported by the condition in which the hat was found on the head of deceased. It is of some importance as a medico-legal fact, that the skin may be readily wounded through the dress, without the latter being necessarily cut or torn. Mr. Baron Wood, who tried the above case, stated at the time that he remembered a trial at the Old Bailey, where it had been proved that a cut and a fracture had been received without having cut the hat of the wounded person, and evidence was then adduced of the infliction of a similar wound without cutting the hat.

I am indebted to Mr. Codd, coroner for Essex, for an instructive case which occurred in August 1853, showing the importance of comparing the article of dress with the injuries which may have proved fatal. A woman, æt. 60, was found dead in her bed. She had vomited slightly, and there was a small quantity of blood on the floor which had flowed from her nose. She had been seen in her usual health on the previous night. On inspection, there were found two indentations about the middle of the right parietal bone, and there was a large clot of blood in this situation beneath the skin. On removing this clot, the bone was found fractured to the extent of four inches. Nearly three ounces of dark clotted blood were found on the outer membrane of the brain (dura mater), between it and the skull. All the other viscera were healthy. This was the only injury, and quite sufficient to account for death; but a question arose respecting the mode in which this fracture was caused. It was in evidence that on the evening before her death, deceased had been suddenly knocked down, while she was walking in a public road, by a man accidentally running against her. One witness stated that she fell heavily on the back of her head, on which at the time she wore a bonnet. She appeared stunned—was raised up by the man—some brandy was given to her, and she recovered sufficiently to walk home and eat her supper as usual, after which no one saw her until she was found dead in bed on the following morning. Some suspicion arose that the violence done to the head was too great to be accounted for by a mere fall, and it was a question whether, with such an amount of injury, the deceased could have walked to her home, at the distance of a mile and a half, and have eaten her supper before going to bed. At first it was thought that this was a case of murder, and a man who lodged in the house with deceased was suspected. His room was searched, and a hammer with two claws was found. On comparing these claws with the two indentations and fracture, the medical witness thought that this weapon would at once account for their production. Deceased and this man had been in the habit of quarrelling, and they were the only persons in the house on this occasion. The lodger said that he let the woman in about nine o'clock (the fall in the road occurred about 7.30); her appearance presented nothing unusual, and he saw no more of her until called at seven the next morning, when she was found dead and cold. It was only at the adjourned inquest that the bonnet worn by the deceased at the time of the fall was called for by the coroner. Two indentations were then found upon the back part of it, corresponding to those on the skull of deceased. The indentations on the bonnet contained dust and dirt, thereby confirming the statements of the witnesses, and rendering it probable that the fall in the road had caused the fatal injury to the head.

The examination of the dress, in this case, cleared up what might have been otherwise doubtful. It is probable that the large internal effusion of blood which caused death did not take place until deceased had reached home, and perhaps as a result of the exertion made. She must have died very soon after she went to bed, as her body was found cold at seven o'clock the next morning. In addition to the caution which this case conveys respecting medical opinions on the origin of wounds, it shows that persons may walk and die at a great distance from the spot where a serious injury to the head has been sustained.

The examination of the clothing in the *Waterloo Bridge* tragedy (page 133) threw some light upon the question of murder. An overcoat presented, in the collar behind and towards the left side, a cut or stab as from a double-edged knife. The undercoat as well as the waistcoat presented the mark of a similar stab corresponding in size, form and direction to the cut in the collar of the overcoat. The shirt beneath was much stained with blood. The stab took a direction from above downwards, and must have penetrated into the chest. Its situation and direction precluded the idea of its having been self-inflicted. As there was no blood on the overcoat where cut, the weapon had not before been used for inflicting a wound, and the deceased had obviously been stabbed from behind with all his clothes upon him. The theory that this was not a murder would involve the assumption that the overcoat, undercoat, and waistcoat had been placed upon some lay-figure for the purpose of imitating a fatal stab behind, and that the undershirt had been covered with blood to add to the appearance. No reasonable motive could be assigned for such a proceeding.

CHAPTER 36.

WOUNDS INDICATIVE OF HOMICIDE, SUICIDE, OR ACCIDENT—EVIDENCE FROM THE SITUATION OF A WOUND—SUICIDAL WOUNDS IN UNUSUAL SITUATIONS—EVIDENCE FROM NATURE AND EXTENT—SHAPE—EVIDENCE FROM THE DIRECTION OF A WOUND—SUICIDAL AND ACCIDENTAL WOUNDS—WOUNDS INFLICTED BY THE RIGHT OR LEFT HAND—ACCIDENTAL AND HOMICIDAL STABS—EVIDENCE FROM THE PRESENCE OF SEVERAL WOUNDS—THE USE OF SEVERAL WEAPONS—TWO OR MORE MORTAL WOUNDS—WOUNDS PRODUCED SIMULTANEOUSLY OR AT DIFFERENT TIMES.

Wounds indicative of Homicide, Suicide, or Accident.—Supposing that the wound which is found on a dead body is proved to have been caused before death, it may be necessary to inquire whether it was the result of *suicide*, *homicide*, or *accident*. It might at first sight be considered that the determination of a question of this nature was wholly out of the province of a medical jurist. In some instances it may be so, and the settlement of it is then properly left to the legal authorities; but in a large number of cases, it is so closely dependent for its elucidation on medical facts and opinions, that juries could never arrive at a satisfactory decision without medical evidence. Let us suppose, then, that a medical jurist is consulted in a doubtful case,—What are the points to which he should direct his attention? They are, with regard to the wound, 1, its *situation*; 2, its *nature* and *extent*; and 3, its *direction*.

1. *Evidence from the situation of a wound.*—It is a general principle in which most medical jurists agree, that wounds inflicted by a suicide, are usually confined to the fore or lateral parts of the body. The throat and chest are commonly selected when cutting instruments are employed; while the chest, especially in the region of the heart, the mouth, the orbit and the temples,

are the spots generally chosen for the perpetration of suicide by fire-arms. But it is obvious that any of these parts may be also selected by a murderer, with the especial design of simulating a suicidal attempt; therefore the mere situation of a wound does not suffice to establish the fact of suicide. Dr. Smith considers, in reference to pistol-wounds, that if the weapon has been introduced into the deceased's mouth and there discharged, we may take it for granted that 'it has not been done by another' ('For. Med.' p. 302); but this inference has been rather too hastily drawn, because it is quite within the range of probability that a cool and calculating assassin may purposely resort to this method of destroying a person in order to conceal the crime. In suicidal wounds from fire-arms, a discolouration by powder of the fingers of the hand which discharged the weapon is sometimes observed; this has also been looked upon as a source of evidence of suicide under doubtful circumstances, but a similar objection, although not with equal force, might be made to its admission. Some have regarded it as fully established in legal medicine, that when wounds exist at the back part of the body, it is a positive proof that they have not been self-inflicted. This situation is certainly unusual in cases of suicide; but, as Orfila observes, it is not the situation, so much as the direction of a wound, which here furnishes evidence against the presumption of suicide. A wound, traversing the body from behind to before in a direct line, is not likely to have resulted from a suicidal attempt: at least, it must be obvious that it would require more preparation and contrivance on the part of a self-murderer, so to arrange matters that such a wound should be produced, than we can believe him to possess at the moment of attempting his life. Besides, his object is to destroy himself as quickly and as surely as circumstances will permit; he is, therefore, not likely to adopt complicated and uncertain means for carrying this design into execution. Nevertheless, we must not always expect to find suicidal wounds in what an anatomist would pronounce to be the most appropriate situation to produce instant destruction. A want of knowledge or a want of resolution on the part of a suicide, or the accidental slipping of the hand, will often cause a wound in a part where we might least expect to find it.

Wounds which result from accident or suicide are generally in *exposed* parts of the body. An incised wound in a concealed or not easily accessible part is presumptive of homicide: because this kind of injury could have resulted only from the deliberate use of a weapon. Suicidal wounds are, however, sometimes found in the most unusual situations. In December 1842, a surgeon destroyed himself by cutting through the brachial artery and the principal veins of his left arm with a penknife: and in another instance which occurred in 1839, a young man committed suicide by dividing the arteries of the fore-arm on both sides. It is very rare that we find suicidal stabs in the abdomen or throat, but an instance occurred a few years since, in which a woman destroyed herself by a stab in the lower part of the abdomen, and several similar cases are recorded by medico-legal writers. In an attempt at suicide, which fell under my own observation, a stab was inflicted by a carving knife on the fore part of the neck traversing the parts from the windpipe to the spinal column. In regard to situation, it has been remarked, that there is no wound which a suicide is capable of inflicting upon himself, which may not be produced by a murderer; but there are many wounds inflicted by a murderer which, from their situation and other circumstances, a suicide would be incapable of producing on his own person. We cannot always obtain certainty in a question of this kind,—the facts will often allow us to speak only with different degrees of probability. A remarkable instance of the singular situation selected for suicidal wounds is reported in the 'Med. Gaz.' vol. 45, p. 439.

The situation of a wound sometimes serves to show whether it is of an *accidental* nature or not—a point often insisted on in the defence. Accidental wounds generally exist on those parts of the body which are exposed. Some

wounds, however, forbid the supposition of accident even when exposed; as deeply incised wounds of the throat, and gunshot wounds of the mouth and temples. For the report of a case in which an accidental wound on the head, by an axe, closely simulated a homicidal wound, see Casper's 'Wochenschrift,' May 24, 1845.

2. *Evidence from the nature and extent of a wound.*—Generally speaking, the wound met with on the body of a suicide, when fire-arms have not been used, is either incised or punctured, *i.e.* a cut or a stab. Contused wounds are rarely seen in cases of suicide, because in producing them there is not that certainty of speedily destroying life to which a self-murderer commonly looks. There are of course exceptions to this remark; as where, for instance, a man precipitates himself from a considerable height, and is wounded by the fall. Circumstantial evidence will, however, rarely fail to clear up a case of this description. Greater difficulty may exist when life is destroyed by a contused wound, voluntarily inflicted. A case is related by a medico-legal writer in which a man first attempted to destroy himself by running with his head against a wall; and not having succeeded in the attempt, he struck himself repeatedly on the forehead with a cleaver. By this he produced such violent injury to the brain, that death soon followed. The man was seen to commit the crime by several witnesses: had not this been the case, the nature of the wound was such as to excite suspicion that it had been inflicted by another, and that the man had been murdered.

A close attention to the *shape* of wounds in the throat made by cutting instruments will sometimes lead to the development of cases rendered doubtful from the circumstances under which the dead body of a wounded person is found. A few years since, the body of a farmer was found lying on a high road, in one of the midland counties. His throat was severely cut, and he had evidently died from the bleeding which had taken place. A bloody knife was discovered at some distance from the body, and this, together with the circumstance of the pockets of the deceased having been rifled, led to a suspicion of murder. The suspicion was confirmed when the wound in the throat was examined by a surgeon. It was cut, not, as is usual in suicides, by carrying the cutting instrument from before backwards, but as the throats of sheep are cut when slaughtered by a butcher. The knife had been passed in deeply under and below the ear, and had been brought out by a semicircular sweep in front, all the great vessels of the neck, with the gullet and windpipe, having been divided from behind forwards. The nature of this wound rendered it at once improbable that it could have been self-inflicted, and it further served to detect the murderer, who was soon afterwards discovered. The prisoner, who was proved to have been a butcher, was subsequently tried and executed for the crime.

When persons labouring under insanity commit suicide, they often inflict upon themselves wounds of an extraordinary kind—such as would, at first view, lead to a suspicion that they had been produced by the hand of a murderer: and, therefore, the rules which are here laid down to distinguish homicidal from suicidal wounds, must be guardedly applied to the cases of those persons who are known to have been insane. In 1850, a case occurred at Guy's Hospital, in which a person in a fit of delirium tore away the whole of the abdominal muscles from the lower and fore part of the abdomen. Had the body of this person been found dead with such an unusual and serious personal injury, it is not improbable that it would have been pronounced homicidal and not suicidal. A woman suffering from delirium tremens tore open her abdomen with her hands. The wound produced was eight inches long, and about eight feet of the small intestines protruded from it as well as a portion of the large intestines, which had been completely torn across. She lived twenty-seven

hours after inflicting this injury. ('Lancet,' 1870, 1, 863.) Such severe injuries as these, if found on a dead body, would probably not be described as self-inflicted, but as indicative of murderous violence. A pregnant woman under a delusion so ripped open her abdomen that a large wound was made, and the omentum and gravid uterus protruded. ('Lancet,' 1870, 2, 258.) A gentleman was found lying in a state of insensibility in the kitchen of his house, with a cleaver by his side. On examining the head, upwards of thirty wounds were found over the back part of the skull. The wounds, many of which were superficial, had a horizontal direction from behind forwards. One, however, had removed a portion of the skull from the middle of the lambdoidal suture, so that the brain had escaped. This person died four days afterwards, but recovered so far as to admit that he had produced the wounds on himself, of which, from other circumstances, there could have been no doubt. He was a lunatic. This was a most unusual way of committing suicide. Had the deceased been found dead on a public highway, thus wounded, the probability is, that a strong suspicion of murder would have arisen. A case of this kind should be borne in mind when we are called upon to speak to the possibility of certain wounds found on a dead body, having been self-inflicted. ('Med. Gazette,' vol. 24, p. 276.) Dr. Ryan met with a case in which a man contrived to cut his throat exactly between the os hyoides and the larynx, having previously made two distinct cuts on the thyroid cartilage. The wound was of an unusual kind, reaching backwards through the pharynx to the spinal column. Dr. Ryan states that there were two cuts on the fourth cervical vertebra and another on the intervertebral cartilage. The carotids and jugulars had escaped, but some of the larger branches of these vessels were divided. The man survived about seven hours. ('Med. Times,' Jan. 17, 1852, p. 73; also 'Lancet,' June 1, 1844. For another case of extensive wounds in the throat by a lunatic, see 'Med. Times and Gazette,' August 27, 1853, p. 219.)

Wounds of the throat, when inflicted by suicides, are commonly at the upper part, involving the os hyoides and the thyroid or cricoid cartilages; the large vessels often escape, but the larynx is opened. The wound does not always cause death by hæmorrhage. A woman, æt. 68, after attending a prayer-meeting, attempted suicide by inflicting a wound on her throat. It was between four and five inches long and extended nearly from ear to ear. It laid open the larynx between the hyoid and thyroid bones, and had taken off a portion of the epiglottis. There was no arterial hæmorrhage, only a few veins having been divided. The patient did well at first, but inflammation of the lungs set in, and this carried her off on the sixth day. This was a secondary cause of death. ('Ed. Monthly Journal,' Feb. 1863, p. 759.)

The *extent* of a wound, by which we are to understand the number and importance of the parts injured, must in these cases be always taken into consideration. It has been somewhat hastily laid down as a rule, that an extensive wound of the throat, involving all the vessels and soft parts of the neck to the spine, could not be inflicted by a suicide. Although in general suicidal wounds of this part of the body do not reach far back, or involve the vessels of more than one side, yet we find occasionally that all the soft parts are thus completely divided. These are cases in which, perhaps, with a firm hand, there is a most determined purpose of self-destruction. In a case of suicide, observed by Marc, the weapon had divided all the muscles of the neck, the windpipe, and gullet—had opened the jugular veins and both carotid arteries—and had even grazed the anterior ligaments of the spine. A wound so extensive as this is rarely seen in a case of suicide, but there is no ground for the assertion that extensive wounds in the throat are incompatible with self-destruction.

Incised wounds in the throat are generally set down as presumptive of suicide, but murderers sometimes wound this part for the more effectual con-

cealment of crime. Circumstances connected with the form and direction of a wound, may in such cases lead to detection, for, unless the person attacked be asleep or intoxicated, resistance is offered—evidence of which may be obtained by the presence of great irregularity in the wound, or the marks of other wounds on the hands and on the person of the deceased. In some instances, however, it is extremely difficult to say whether the wound is homicidal or suicidal—the medical facts being equally explicable on either hypothesis. (See case by Marc, 'Ann. d'Hyg.' 1830, 2, 408; another by Devergie, ib. 414; and a third by M. Ollivier, 'Ann. d'Hyg.' 1836, 1, 394.) *Regularity* in a wound of the throat has been considered to be presumptive of suicide. This was the publicly-expressed opinion of Sir Everard Home in the well-known case of *Sellis*. The deceased was found lying on a bed, with his throat extensively cut, and the edges of the incision were regular and even. This condition of the wound, it was inferred, repudiated the idea of homicide, but as a general principle this appears to me to be a fallacious criterion. A murderer, by surprising his victim from behind—by having others at hand to assist him, or by directing his attack against one who is asleep or intoxicated, or who from age or infirmity is incapable of offering resistance, may easily produce a regular and clean incision on the throat. This was observed in the case of *Lord William Russell*, who was murdered by Courvoisier in 1840. The wound in the throat possessed all that regularity which has been so improperly regarded as characteristic of suicide. Some have taken a contrary view to that of Sir E. Home; and have contended, with more plausibility, that the chief character of a suicidal wound in the throat, is great irregularity, from want of steadiness in the hand during the perpetration of suicide. It is by no means unusual in suicides to find the cut regular at its commencement, and irregular or uneven at its termination, from the loss of blood which attends the first incision; but it is obvious that a homicidal wound might possess these characters. In short, from the foregoing remarks, we are, I think, entitled to say, regularity or irregularity in an incision in the throat furnishes no presumptive evidence either of homicide or suicide.

The nature and extent of a wound or of other injuries on the person will sometimes allow us to distinguish *accident from homicide*. These personal injuries may be such, that they could not possibly have had a suicidal or accidental origin. In a case that occurred at Manchester, in October 1836, it was shown by the medical evidence that seven ribs were fractured on one side of the chest of the deceased and five on the other. The person charged with murder alleged in defence that he had merely struck the deceased a slight blow, and that the ribs were broken subsequently by an accidental fall. The medical witness, however, satisfied the Court that the fall, as described by the prisoner, was inadequate to the production of such extensive violence; and that even had the deceased fallen on *one* side, this would not account for the fracture of the ribs on the *other*. When, therefore, we find in a dead body severe injuries referred to a fall, we should search the whole of the body carefully for proofs of violence. The insides of the arms or thighs might present marks of injury, which could not possibly be explained on the supposition of an accidental fall. Severe contusions on both sides of the body, or anteriorly and posteriorly, commonly indicate homicidal violence. Some years ago I assisted in examining the body of a woman who was alleged to have been murdered by her husband. The body presented numerous marks of contusions; one arm was completely ecchymosed from the shoulder to the hand. The person charged with the murder ascribed these appearances to the fact of his wife having accidentally fallen out of bed; but on examining the bed, it was found to be only a foot from the floor. A fall from this height would not account for the presence of such extensive marks of violence; but irrespective of this, a severe contusion was found on the outer side of the opposite thigh, which, from the

appearance, must have been produced about the same time as that on the arm. The existence of this second contusion rendered the defence still less probable: for the woman could not, if she had fallen at all, have fallen on both sides of her body at once; and it was not alleged that she had had more than one fall. In the case of *Reg.* v. *Wallis* (Cent. Crim. Court, 1839), a similar defence was set aside, by the fact that distinct and severe bruises were found on the back of the head and on the temples of the deceased.

3. *Evidence from the direction of a wound.*—The direction of a wound has been considered by some to afford presumptive evidence sufficiently strong to guide a medical jurist in this inquiry. It has been remarked that in most suicidal wounds which affect the throat, the direction of the cut is commonly from left to right, either transversely or passing obliquely from above downwards: in suicidal stabs and punctured wounds, the direction is commonly from right to left and from above downwards. In left-handed persons, the direction would, of course, be precisely the reverse. Suicidal wounds are, however, subject to such variation in extent and direction, that it is scarcely possible to generalize with respect to them. Nevertheless, an attention to these points may sometimes be of real assistance to the inquirer, especially when the body has not been moved from its position. It is recommended that the instrument with which the wound has been inflicted should be placed in either hand of the deceased, and the extremity moved towards the wounded part, so that it may be clearly seen whether the direction of the wound could or could not correspond to it in any position. It might happen that neither arm would reach the wounded part, so as to inflict a wound of the particular direction observed: this may be the case in wounds situated on the back. It is however obvious, that if a murderer makes an incised wound in the front of the throat from behind, the direction will be the same as that commonly observed in cases of suicide. (See on this point the case of *Reg.* v. *Dalmas*, Cent. Crim. Court, May 1844.) Again, if the person attacked is powerless, the wound may be deliberately made, so as to simulate a suicidal act; indeed murderers seldom attack the throat, but with the design of simulating an act of suicide. A homicidal stab may also take the same direction as one which is suicidal, but this would be confined to those cases in which the assailant was placed behind or aside. If in front of the person whom he attacks, the direction would probably be from left to right; but in suicide, when the right hand is commonly used, it is the reverse. Oblique wounds, passing from above downwards, are common to homicide and suicide, but those which take an oblique course from below upwards are generally indicative of homicide, for it is extremely rare, that a person bent on suicide, unless a lunatic, thus uses a weapon. Homicidal incisions, especially in the throat, are often prolonged below and behind the skin forming the angles of a wound, deeply into the soft parts (case, p. 483). Those which are suicidal rarely possess this character; they terminate gradually in a sharp angle, and the skin itself is the furthest point wounded,—the weapon is not carried either behind, below, or beneath it. Exceptions to these characters may exist; but in a dark and intricate subject of this nature, we have only these limited rules to guide us. The instrument with which a wound is supposed to have been inflicted should be adapted to the edges of the incision: its sharpness compared with the cleanness and evenness of the cut, and its length with the depth of the incision or stab. It is no uncommon occurrence for a murderer to substitute some instrument, belonging to the deceased or another person, for that which he has actually employed; and this by its size, shape, bluntness, or other peculiarities, may not account for the appearances presented by the wound.

Suicidal and Accidental wounds.—It is not often that any difficulty is experienced in distinguishing a *suicidal* from an *accidental* wound. When a

wound has really been suicidally inflicted, there are generally to be found about it clear indications of design; and the whole of the circumstances are seldom reconcilable with the supposition of accident. But if the position of the deceased with respect to surrounding objects has been disturbed, if the weapon has been removed, and the body transported to a distance, then it will not always be easy to distinguish a wound accidentally received from one inflicted by a suicide or a murderer. The evidence of those who find the body can alone clear up the case; and the medical witness may be required to state how far this evidence is consistent with the situation, extent, and direction of the wound by which the deceased has fallen. It is unnecessary to dwell further on this subject, since the observations already made will suggest to a practitioner the course which he should pursue. Circumstantial evidence is commonly sufficient to show whether a wound has been accidentally received or not; but as an accidental wound may sometimes resemble one of homicidal or suicidal origin, so it follows that it is not always possible for a medical jurist to decide the question peremptorily from a mere inspection of the wound.

It would not be difficult to produce instances in which murderers, in their defence, have alleged that the wounds observed in the bodies of their victims were of accidental origin, and the allegations have been clearly refuted by medical evidence. A witness must be prepared, therefore, in all cases in which death has taken place in secrecy, and the nature of the wound is such as to render its origin doubtful, to be closely examined by counsel for a prisoner charged with felonious homicide, on the question whether the wound might not have been accidental. The law requires that it should be rendered evident to a jury, before such a charge can be sustained, that the fatal wound could not have had an accidental or suicidal origin.

The death of a person from wounds has hitherto been considered as a subject connected with a criminal charge; but an investigation of the circumstances under which death ensues, is occasionally rendered necessary when the deceased has effected an insurance upon his life. A policy of life-insurance is in some cases rendered void by the act of self-destruction; and therefore a person bent on suicide might, for the sake of his family, take precautions to conceal the manner in which he intended to destroy himself. His body might be found wounded in a way which would render it uncertain whether he had been wounded accidentally, whether he had been murdered, or whether he had fallen by his own hand. In a disputed case it is incumbent on the office to prove the act of suicide (*felo de se*), while the relatives of the deceased would attempt to show the contrary. Such litigation must, of course, call forth a deep and searching investigation into all the circumstances connected with the death of the insured, and the whole case would, in some instances, rest almost exclusively on medical evidence. ('Med. Gaz.' vol. 36, p. 826.) Numerous cases have of late years occurred in England, which will illustrate the importance of attending to the precise characters of wounds, and the circumstances under which the body of a wounded person is found. The following may serve as illustrations:—

Wounds of the throat.—The extent and direction of fatal wounds affecting this part of the body, if accurately observed, will frequently enable a medical jurist to express a strong opinion on the question whether the wound was self-inflicted or inflicted by the hand of another. The blood-vessels and nerves likely to be involved in such wounds will depend on their situation and depth. The annexed illustration (fig. 93) shows the relative position of the carotid artery, jugular vein, and their principal branches, as well as the nerves of the right side of the neck. Those parts only are made subjects of reference in the figures which may require description in medical evidence. The purely anatomical references are omitted.

In the year 1837, the late Mr. Dodd, of Chichester, consulted me on the following case:—He was called to examine the body of a woman, who was found with her throat cut. The deceased, when seen by him, was lying on her back, and the razor with which the wound was inflicted was found under the left shoulder. On inquiry it was ascertained that when first seen, she was lying on her face, and the body had been turned round on the back. Blood had evidently run down the fore part of her person, rendering it probable that she

Fig. 94.

View of the Blood-vessels and Nerves of the side of the neck, from a drawing by J. T. Gray.—5. Internal jugular vein. 8. Lingual artery. 9. Pneumogastric nerve. 11. Phrenic nerve. 12. Superior thyroid artery. 13. Sterno-mastoid muscle, turned back. 14. Common carotid artery. 15. Inner end of collar-bone, turned back. 16 and 18. Muscles covering the larynx and trachea (windpipe).

had been wounded while in the erect position. The incision in the throat was deep, and extended obliquely from the right side of the chin to within about an inch of the left collar-bone. It had divided the windpipe, the gullet, all the muscles of that side and the fore part of the neck, the carotid artery, jugular vein, and the muscles on the fore part of the spine, penetrating even into the bodies of the vertebræ of the neck. The incision was double—one superficial, close under the chin, and the other a deeper one, appeared to be continued from this. The deepest part of the right end of the incision was nearly three inches in a direct line behind the right angle of the wound, so that it extended at that part behind and beneath the sound skin. The cut was four and a half inches long and two and a half deep. The main question was, whether this could have been a suicidal wound, inflicted by a razor, the only weapon found near the body. Considering its characters, Mr. Dodd inferred that it must have been inflicted by another person, and not by the

deceased upon herself. The deceased was right-handed, which would have added to the difficulty of supposing the wound to have been suicidal. The inference drawn was precisely that which the medical circumstances appear to me to justify.

In March 1860, I was consulted in a case which subsequently gave rise to a trial for murder. With every desire to make full allowance for severe and extensive wounds being produced by persons intent on suicide, there must be a reasonable limit to these admissions, or we may arrive at the unsatisfactory conclusion that a man might cut off his own head and afterwards dispose of the weapon at a distance. A young woman was found dead in a farm-house from a wound in her throat. This wound was seven inches long and two inches in depth: it was situated on the left side of the neck, its direction was nearly transverse, but passing slightly upwards from behind forwards. The incision commenced a little in front of the spine on the left side opposite to the second or third spinal process, and terminated about an inch and a half from the centre of the chin, the fore part of the incision being over the body of the lower jaw and quite superficial, dividing only the skin, cellular tissue and fat. The important parts involved on the left side were, the external and internal carotids, which were cut into but not across; the internal jugular vein, the pneumogastric nerve, and (at the posterior part of the wound) the spinal cord, were completely severed. The weapon nearly entered the joint between the second and third cervical vertebra, about two-thirds of the intervertebral substance between these bones having been divided. A portion of the second vertebra had been cut through, and was left adherent to the lower lip of the wound. The left vertebral artery was also completely divided. The lower lip of the wound was jagged and serrated, and the neck was slightly wounded lower down on the same side, showing that several strokes had been made in this part with the weapon. In the *left* hand of deceased a common dinner knife was found, loosely *held*; it was in a reversed position, with the back instead of the blade towards the throat. The left hand presented three incised wounds over the middle finger, one of considerable depth, and another reaching to the bone over the outer side of the ring finger. The right hand had only one slight wound upon it. The deceased was *right-handed.*

Measured by any scientific rules, such a wound as this was inconsistent with an act of suicide. Assuming that it had commenced behind, the spinal marrow was divided in such a situation that there would be instantaneous destruction of all muscular power, so that the weapon could not be carried forward to the division of the jugular vein and the two principal branches of the carotid artery in front. Assuming that the wound had commenced in front, the division of these large vessels would have rendered it impossible, by reason of the copious loss of blood, to have carried the weapon through the intervertebral substance to the division of the spinal marrow and vertebral artery behind.

There could be no doubt that the wound commenced behind on the left side, and that the weapon was used with great force to cause a division of the bony process of the second vertebra. Its situation, extent, and direction were all inconsistent with suicide. A suicide could have inflicted a wound in this situation and direction only with the right hand, but the weapon was lying loosely in the *left* hand of the deceased. There were deep recent cuts on the back of the left hand which admitted of explanation only on the supposition that the deceased had raised it to protect her throat. No suicide scores the backs of the hands before inflicting fatal wounds on the throat. A fellow-servant of the deceased, although not at first suspected, was tried at the Carlisle Summer Assizes, 1860 (*Reg.* v. *Cass*), and convicted of this act of murder upon his own confession. His clothes were sent to me for examination, and it is worthy of observation that, with the exception of a few small spots on the shirt, they

were free from any marks of blood. The knife found in the hand of the deceased was bent towards the end as if it had been used against some hard obstacle. It had been wiped; but it still contained in its depressions and irregularities, as well as between the layers of the handles, coagula of recent blood mixed with rust. One remarkable circumstance, brought out by the microscope, appeared to connect the prisoner with this weapon. In a small coagulum found on the knife, dried and fixed to the blade, were some woollen fibres of a peculiar purple brown dye. These corresponded exactly to the fibres of the woollen jacket which the prisoner wore.

Another case possessing some equally remarkable features was referred to me by Sec. Sir George Grey, in Dec. 1862 (*Reg.* v. *Edmunds*, Swansea Lent Assizes, 1863). A young woman named *Jane Lewis* was found dead with her throat cut, lying in a pathway not far from the house in which she resided as servant, and a razor taken from the house was lying near the body. She had left home perfectly well about seven hours previously, to keep an appointment with the man who was charged with the murder. This man was a fellow-servant to whom she was about to be married. There were three distinct and deeply incised wounds in the neck made from left to right—the upper one four inches in length, commencing below the left ear and running parallel to the jawbone; the middle cut about seven inches in length, commencing at the same point and running across the middle of the neck to a spot behind and below the right ear; and the lower cut six inches in length, commencing above the middle of the left collar-bone going in a perpendicular direction, and terminating in the front of the neck by joining the middle incision. The middle cut divided the windpipe, the gullet, and all the great vessels and nerves in front of the neck to the neck-bone. There were two distinct cuts into the spinal column about the third cervical vertebra, one penetrating deeply into the upper edge of the bone, and the other a quarter of an inch below it, commencing on the body of the vertebra and running more deeply to the right side. This divided the transverse process of the vertebra, opened the joint between it and the bone, and severed the vertebral artery. There were deep cuts, which had bled, on the inside and outside of the left hand; and the pad of the middle finger of the right hand had been sliced off, and was found wedged in the joint of the razor. This was half open and lay a yard behind the body. There was no blood upon the handle, while the hands of the deceased were bloody. The deceased's bonnet was found covering a large patch of blood near the razor. A collar which she wore, as well as the strings of her bonnet, had been cut through, and these like the razor were at a distance from the body. It is scarcely necessary to adduce reasons for showing that these wounds could not have been inflicted by deceased upon herself. Apart from all the surrounding circumstances, and looking at the medical description only of the situation, nature, extent, and direction, Mr. Davies, the surgeon, was quite justified in saying that 'it was impossible for any person to inflict such wounds upon himself.' The hacking of the bones of the spinal column in *two distinct places* with such force as to cut off a part of the bone, after both carotid arteries and jugular veins had been cut through, was alone sufficient to justify this opinion. In order to produce these marks, the razor must have been obviously twice used with great force through the same deep incision. There could be no reasonable doubt that this was an act of deliberate murder; but there was a failure of proof to trace it to the accused.

Suicides may graze the ligaments in front of the spinal column, but that they should make deep incisions into the bones, cut off hard bony processes, and divide the intervertebral substance and the vertebral arteries, is a proposition contrary to all experience and probability. The case of the *Earl of Essex*, who was found dead in the Tower in July 1683, bore somewhat on these points. The

deceased was discovered with his throat cut, and a razor lying near him. This razor was found to be much notched, while the throat was smoothly and evenly cut from one side to the other and to the vertebral column. Some considered this to have been an act of suicide, others of murder. Those medical witnesses who supported the view of suicide were asked to explain how it was that such an even wound could have been produced by a notched razor. They attempted to account for this by asserting that the deceased had probably drawn the razor backwards and forwards across the neck-bone; forgetting that before this could have been done by the deceased, all the great vessels of the neck must have been divided! In *Reg.* v. *Heywood* (Liverpool Winter Assizes, 1855), it was proved that deceased had died from a wound in the throat extending six inches from right to left, by which the upper portion of the windpipe was severed as well as the branches of the carotid artery. Her face was concealed by a pillow, the arms were crossed, there was a razor in her right hand, and the back of the razor was towards the body. The hands were clean. A pillow on the other side of the bed was bloody underneath. All these circumstances clearly indicated homicide and homicidal interference after death. The prisoner was convicted. In a former part of this work (pp. 68, 85) I have referred to the case of *Gardner* (*Reg.* v. *Gardner*, C. C. C., 1862). Among various medico-legal questions to which this case gave rise, was that which we are now considering. Were the wounds in the throat inflicted by deceased on herself or by another person? Without going minutely into details, it may be stated that Mr. H. Sequeira, the surgeon who was called, found the woman dead, blood was copiously effused, but only on each side of the neck, not in front of her person. A large table-knife was loosely placed in her right hand; it was lying in the direction of the length of the body, the back of the blade towards the chest, and the sharp edge in front. There was dry blood upon the blade and handle. The annexed illustration, fig. 94, made from a drawing on the spot by Mr. H. Sequeira, shows the exact position in which the body was found on the floor of the room. It was lying at full length in a corner by an open door as if laid out, the right arm which held the knife being partly under a bed, as indicated by the line which traverses it. The wound in the throat cut through the bone and thyroid cartilage of the larynx, dividing the thyroideal artery, causing a flow of blood and death by suffocation. It commenced over the larynx as by a deep stab, and extended for about two inches downwards and backwards on the left side. It must have been inflicted while deceased was lying down, and under the circumstances it was not such a wound in the opinion of the medical men as a woman could have inflicted on herself while in this position.

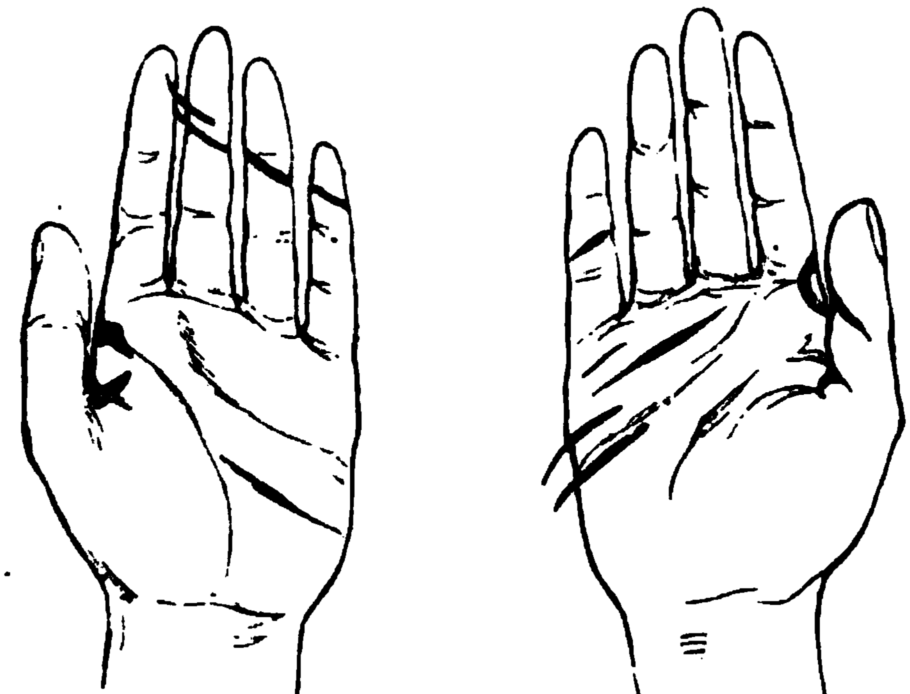
Fig. 96.

Position of the body of Mrs. Gardner (*Reg.* v. *Gardner*, Central Criminal Court, 1862).

The knife was lying *loosely* in the right hand of deceased, and the small quantity of blood on the palms presented the appearance of smearing or wiping. On these facts being proved, it became simply a question which of two persons then in the house was guilty of this act of murder. The husband was convicted of this crime. In homicidal wounds of the throat, the hands of the deceased, either back or front, frequently present marks of recent cuts. These injuries arise from an instinctive effort to protect the throat under a sudden attack. It need hardly be said that a person contemplating self-destruction by wounding the throat would

not begin by making cuts across the hands. Sometimes the weapon may be so grasped by the person attacked as to cause numerous cuts on the front of the hand. These will of course bear the characters of recent cuts. Their presence should admit of some reasonable explanation. In the case of *Gardner* (supra), this was one of those facts properly considered to be inconsistent with the innocence of the prisoner. The palms of the hands of deceased presented numerous fresh cuts in the positions shown by the annexed illustrations, fig. 95. The sharp blade of the knife had probably been grasped by deceased before her death, in resisting the attack. There were four cuts on the left hand and six on the right. Some of the cuts were across the fingers. Of two on the middle finger of the left hand one had gone completely through to the bone.

Fig. 96.



Case of Mrs. Gardner. The recent cuts on the palms of the two hands are here shown by the dark lines.

Another case of some importance in which a man was tried and convicted of the murder of a woman living with him as his wife, was the subject of a trial at the Central Criminal Court (*Reg.* v. *Wiggins*, Sept. 1867). The woman was found dead with a wound in her throat which divided the carotid artery, the internal jugular vein and the trachea. It commenced on the left side far back, penetrating as by a stab perpendicularly towards the spine, the bones of which had been indented by the violence of the blow. Death must have speedily followed. There was a wound on the neck of the prisoner commencing on the left side, going in a direction from left to right and from above downwards. It was quite superficial, involving only the skin and the external jugular vein. The prisoner alleged that the deceased had cut his throat while he was lying on the floor asleep, and that she had afterwards destroyed herself.

A close examination of these wounds showed that on the prisoner's neck there was a superficial cut such as a man might easily produce on himself, while the wounds on the neck of the woman were such as were not likely to have been self-inflicted. There were many circumstances in this case which only admitted of explanation on the theory that a murderous assault had been committed on the woman by the prisoner, and that he had subsequently inflicted the wound in his own neck, to give some plausibility to the story that his wife had attempted to murder him while he was lying asleep. He gave two accounts of the transaction not consistent with each other, nor with any of the facts proved in the case. Among the circumstances which were inconsistent with his statement was the following:—He produced a thin red cotton neckerchief which he said he wore while lying down, and showed the constable a cut in the handkerchief which, according to him, was produced by the deceased while attempting to cut his throat. This neckerchief was examined by Dr. Wilks and myself. It was of thin red cotton in sixteen folds. It was nearly transversely cut across the folds, the edges clean and sharply cut, and neither stained nor stiffened by blood. It could not be made to correspond in any way to the cut in the neck. It was nearly at right angles to it, and on the opposite side of the neck as it was worn. It was obvious, from a close examination, that the cut must have been made on this cotton-handkerchief when it was not upon the neck, and with a clean knife. For a full account of this singular case, which presented

points of interest in reference to the probable time of death, the attitude of the body, the power of locomotion and exertion after a wound of the carotid artery, the jugular vein and trachea, and the medical inferences from blood-stains on clothing, I must refer the reader to a paper in 'Guy's Hospital Reports,' 1868, vol. 14, p. 112.

It is most important on these occasions that there should be no disturbance of the body, of the weapon, articles of furniture, or other matters in its immediate vicinity. If the body or the weapon has been carelessly moved or the arrangement of the clothes altered, this may materially affect a medical opinion. There is no case in medical jurisprudence, in which the rule *prius est de crimine quam de reo inquirendum*, is more rigidly enforced than in reference to these wounds of the throat, whether the wounded person survives or dies. Hence much consideration is required before we come to the conclusion that the act was certainly homicidal. It will greatly aid the effect of medical evidence in reference to the situation and direction of wounds in this part of the body, if at the time of inspection a rough diagram of the neck in its fore and back part is made, and lines are so carried as to indicate, by arrows, the direction which the weapon is supposed to have taken. A Court will thus be able to follow more completely the description given by a medical witness, and to appreciate more readily the reasons which he assigns for his opinion. It would be well if, before a body is moved, a photograph could be taken of the attitude and position of surrounding objects in relation to it. (See on this subject 'Ann. d'Hyg.' 1848, 1, 433.)

Wounds inflicted by the right or left hand.—Some remarks have been made in reference to the direction of a cut or a stab varying according to whether the right or the left hand has been used by a suicide. It is necessary for a medical jurist to be aware that there are many persons who are *ambidextrous*, *i.e.* who have equal facility in the use of the right and the left hand. This may not be generally known to the friends of the deceased; and such persons are often pronounced, even by those who had associated with them, to have been right-handed. A want of attention to this point is said to have been one of the circumstances which led to a suspicion of murder in the case of *Sellis*. (Wills' 'Circ. Evidence,' p. 97.) This man was found dead on his bed with his throat cut—the razor was discovered on the left side of the bed; whereas it was generally supposed and asserted that he was a right-handed man. The truth was, he was ambidextrous—equally expert in the use of the razor with his left and right hand; and thus the apparently suspicious circumstance of the razor being found on his left side was at once explained away. In November 1865, a case of suicide by cut throat occurred in London, which shows the necessity of caution in forming an opinion in these cases. A man known to be right-handed was found dead with his throat cut; it proved to be what is called a 'left-handed cut,' *i.e.* done with the left hand. It appeared in evidence that deceased was brought up as a wood-carver, a trade which requires a man to use both hands equally well. Thus the cause of the wound being in an unusual direction for a right-handed man was satisfactorily explained.

Accidental stabs.—Severe incisions on vital parts do not often happen by accident, but severe punctures and stabs affecting vital organs have frequently an accidental origin. These stabs arise generally from falls, while the person is in the act of running with a pointed instrument in his hand or his pocket. There is one character which, when thus produced, they are commonly observed to possess, namely, that their direction is from below upwards. In this way the truth of a defence may be sometimes tested, as when a prisoner alleges that the deceased threw himself or fell upon the weapon. Homicidal stabs may be likewise directed from below upwards; but this is somewhat rare, and not probable, unless the person is stabbed by an oblique blow, while in the

recumbent posture. Rules of this kind may appear to be susceptible of but little practical application; yet cases occasionally present themselves wherein a close attention to situation and direction may materially assist a medical jurist in forming an opinion. In a case of alleged murder, which was tried in 1843 at the Central Criminal Court, a surgeon deposed that he found, on examining the body of the deceased, a stab on the left side of the chest, near the armpit, about six inches in depth. It had wounded the lung, and had penetrated obliquely into the right auricle of the heart, passing from left to right. He contended, very properly, that, considering the situation and direction of this wound, it was very improbable that the deceased could have inflicted it upon himself. The fact that there may be some instances in which rules of this kind will not be applicable, must not deter us from endeavouring to make a cautious application of them in doubtful cases.

The following cases show how accidental may simulate homicidal stabs. A blacksmith, while forging a piece of rod-iron, was irritated at some observations made by a bystander. He made a rush at the offender with the heated iron in his hand, the end being red-hot; he stumbled and fell. In some way the piece of iron became accidentally reversed—he fell upon the red-hot point, which struck against a portion of the breast-bone, glanced from that, and penetrated the upper part of the left lung. He died in a few days, and the body was examined by order of the coroner. Had only one person been present when this circumstance occurred, a charge of murder might easily have arisen, and the medical and circumstantial evidence might have appeared to favour this view. ('Dublin Med. Press,' January 1845.) How could such an occurrence have taken place by any conceivable accident? The late Mr. B. Cooper relates a case in which a man accidentally inflicted upon himself a stab under very singular circumstances. ('Med. Gaz.' vol. 36, p. 264. See also case by Mr. Ollivier, 'Ann. d'Hyg.' 1843, 2, 169.)

The following case is one of some interest in a medico-legal view:—In May 1843, a man was brought to Guy's Hospital with a punctured wound in the back, between his shoulders. It had been inflicted by a stonemason's chisel. The instrument had penetrated to its head, which had prevented it from going further, and had entered the chest, producing a severe wound as it was supposed of the lungs, attended with copious hæmorrhage. It appeared that the man had been drinking and quarrelling with some companions. He had fallen from a blow, but did not complain of being stabbed, and was conveyed home. His wife, on removing his coat, found that his waistcoat and shirt had been penetrated by the chisel, which was still sticking in his back, but the outer coat had not been cut or perforated by it. She withdrew the instrument, when copious bleeding came on; and he was sent to the hospital. The person with whom he had fought was charged with having stabbed him; and it was clear that such a stab must have been either homicidal or accidental. It was elicited from witnesses, however, that no weapon was seen in the hands of the accused —that the chisel belonged to the wounded man, and that he used it in his trade as a stonemason; there were no marks of blood on the floor where he fell, or on his clothes; that after leaving the public-house where the quarrel took place, he walked with a policeman, who said that the man exhibited no signs of having been wounded, and did not complain of having been struck by any weapon. These facts seemed to show that the stab must have taken place after the quarrel; it was further proved that the wounded man had the chisel in his pocket before the quarrel, and that as the outer coat had not been cut, a homicidal stab could only have been inflicted by the assailant raising this, which was altogether improbable: and then it would remain to be explained how the weapon could have penetrated up to its head.

From the whole of the facts, it was considered that this must have been an

accidental stab; although its direction, as such, was remarkable, since, according to the wife's statement, the weapon had not entered the body in a slanting direction, but straightforward, and it required considerable force to remove it. The man recovered, and from the statement which he made, there could be no doubt that it was an accidental stab produced by a fall; but it was certainly extraordinary that it should have been found in such a situation, and taking such a direction. On these investigations, some regard must always be had to the helpless state of intoxication in which a wounded person may be. This may give an anomalous character to accidental stabs or punctures, and render a man unconscious of a severe injury. The case further illustrates the importance of examining the dress. Had the act been homicidal, the coat would have been found perforated.

At the trial of a *Mrs. Mackinnon* for murder (1823), a careful observation of the direction of a stab in the chest clearly proved the falsehood of a defence. The deceased had been stabbed with a knife, and on an inspection of the body, it was found that the wound, which was situated over the cartilage of the second left rib, penetrated towards the left, backwards, and very much downwards, into the lungs. On the part of the prosecution it was alleged that the prisoner held a long table-knife dagger-wise, and struck the deceased in a direction downwards, forwards, and to her right side. The prisoner alleged in defence that she merely held the knife before her, sloping upwards to deter the deceased from attacking her; that he stumbled forward and fell upon the point of the knife. This statement was in some measure confirmed by the bystanders. As the witnesses on both sides were intoxicated and of disreputable character, the important medical fact to guide the jury was the *direction* of the wound. This was wholly inconsistent with the statement of the prisoner, but in accordance with the evidence for the prosecution. ('Ed. Monthly Journal,' Nov. 1851, p. 418.)

Foreign tribunals in questions of this nature have taken evidence on the stature of the assailant and deceased, as an aid to solve the question whether a stab was the result of accident or homicide. A trial took place in Rome (Case of *De Lucca*, Rome, April 1872) in which during a quarrel between the Pope's guards and some soldiers, one of the former fell dead from a bayonet wound in his side between the sixth and seventh ribs. The medical evidence showed that the wound took a horizontal direction and caused death by dividing the vena cava. The medical witnesses who were called for the prosecution deposed that the deceased *De Lucca* was more than six feet in height, while the person alleged to have inflicted the stab was short, being under five feet. On this ground they alleged that if wilfully inflicted, a bayonet thrust from so short a man as the prisoner must have taken a decidedly upward direction instead of a horizontal one! They seem to have forgotten that by raising his musket with both hands, the prisoner might have inflicted a stab taking either a horizontal or even downward direction in spite of the difference of stature. The evidence rendered it probable that the deceased, in attempting to wrest the musket from the prisoner, accidentally drew it towards him and inflicted the bayonet wound on himself. The prisoner was acquitted. It may be here observed that accidental stabs when persons are standing upright are commonly horizontal. Mr. Watson describes the case of a man who, while performing in 'Rob Roy,' and when the stage was obscured by smoke, accidentally ran forward upon the bayonet of one of the soldiers and thus received a horizontal stab in the chest, from which he died in a few seconds. ('ON HOMICIDE,' p. 276.) In August 1858, an inquest was held on the body of a man who had died from an accidental stab under the following circumstances. *Lieutenant Clavering* and a friend were walking late at night near Acton, when they were attacked by the deceased who was intoxicated. In self-defence Lieut. Clavering

raised a sword-stick which he carried; the deceased pulled at it, and thus unsheathed it, the lieutenant keeping the sword pointed outwards in self-defence. The deceased fell, but it was not known at the time that he had been stabbed, as he was helplessly intoxicated. At the first place where there was a light on the road, the lieutenant and his friend examined the sword, and they saw no blood upon it. The drunken man was picked up dead, and on examination it was found that he had died from a penetrating wound in the chest, involving the heart. It commenced on the right side of the right nipple, was seven or eight inches long, going straight across the chest to the heart. It must have been given or received when the deceased was standing sideways. The medical witness properly admitted that this direction was quite consistent with accident, and with the mode in which the lieutenant and his friend had stated that the wound had been inflicted. The only unintelligible part of the case is that the lieutenant holding a sword, point outwards, should not have been aware, either by its entrance or withdrawal, that it had penetrated a human body, when the circumstances were such as to render such an accident highly probable.

In *Reg.* v. *Carver* (Guildford Aut. Ass., 1870) prisoner was charged with the murder of his wife by stabbing her in the chest with a knife. The medical evidence showed that the wound was between the fourth and fifth ribs of the left side. It was four inches deep, and had penetrated to the heart. It caused death in two or three minutes. The defence was that the deceased rushed at the prisoner while he was holding the knife in his hand. The direction of the wound was described as straight or transverse, and the surgeon thought it might have been caused by the woman rushing on the knife in the manner described. In answer to the judge respecting the precise direction of the wound, the witness said it was rather upwards towards the heart. There were other marks of violence about the deceased, showing that she had been ill-treated, and there was evidence of the prisoner having been seen to strike her about the time at which she was wounded. Upon this evidence he was convicted.

A remarkable case involving a similar question was tried at the Central Criminal Court (*Regina* v. *Davy*, July 1871). The prisoner was charged with the manslaughter of F. G. Moon under the following circumstances. A fall was heard in the dining-room, and on persons going in they found the deceased on the floor dying from a wound in his chest. The prisoner said in answer to an inquiry: 'I am afraid I did it, but I don't know how; it must have been done in the scuffle.' The knife—a large table-knife taken from the knife-box on the sideboard—had been removed from the wound, and was lying within the fender. There was evidence of threats and quarrelling between the parties, but the defence at the trial turned mainly on this medical question: 'Was the wound such as might have resulted from accident during a scuffle, or did it carry with it clear and undoubted proofs of design?' According to the evidence given by Mr. Savory of St. Bartholomew's Hospital and by Mr. Baker, who made the inspection of the body, the wound penetrated the left side of the chest between the sixth and seventh ribs, reaching and wounding the apex of the heart. The wound was downwards, forwards, and inwards in one uniform direction—straight from end to end, and had never changed its course. The obliquity of the ribs allowed of its reaching the apex of the heart. There was not the slightest upward tendency in the direction of the wound. The opinion of Mr. Savory was 'that the wound must have been inflicted by another person stabbing the deceased, and that it was caused by one blow given with considerable force.' He could not suggest any theory satisfactory to himself by which the wound could have been caused accidentally. Other surgeons gave evidence to the same effect.

The annexed engraving (fig. 97) is reduced from a photograph of a subject arranged by Mr. Savory. It shows where the knife entered between the ribs, and the direction which it took from the lower margin of the sixth rib at the side to the lower margin of the seventh rib in front. The wound in the skin, which is here removed, was about two inches further back. Its exact situation is indicated by a pin projecting from the under edge of the sixth rib.

Fig. 97.

Side view of the ribs, showing the direction of a stab traversing the heart. (*Reg. v. Davy.*)

The astute counsel who defended the prisoner, after making the suggestion that 'two medical gentleman of equal eminence attending a post-mortem examination of this kind, might come to a different conclusion as to the *course* such a wound took,' *i.e.* might differ on a simple question of *fact*, put the following question to Mr. Savory.

'Do you believe it was impossible that the body of Mr. Moon should have fallen on the knife and so inflicted the wound?'—*A.* 'I cannot account for it in that way.'

'Do you believe it was impossible?'—*A.* 'I do. I will not swear unconditionally that it was impossible, because my judgment may err; but I believe it to be impossible.'

By the Jury.—The wound being from above downwards, the pressure must have come from above, whereas in the case of a falling body the pressure would come from below.

For the defence four surgeons were called, who thought the wound might have been caused by the deceased in pulling down the knife upon himself during a struggle with the prisoner. One believed that the knife might have been driven into the apex of the heart by a fall. The usual appeal was then made to the jury to acquit the prisoner on the ground of the conflicting opinions expressed in the case, and the difficulty which the jury must necessarily experience in seeing their way to a verdict of guilty, &c. This appeal had no effect with the jury, who took a common sense view of the matter, and found the prisoner guilty. She was sentenced to penal servitude for eight years.

I believe that in the minds of unbiassed persons, there is no other view to be taken of this case than that expressed by Mr. Savory, namely, that this wound from its situation, direction, and depth, was the result of an act of deliberate stabbing, and that no accident could reasonably explain it. The firmness and decision with which Mr. Savory gave his evidence is worthy of imitation on all similar occasions. No case of this kind is ever likely to come before a Court of Law in which there will not be conflicting medical opinions,

and if such a conflict is to be made a ground for the discharge of persons accused of these serious crimes, there will be no convictions.

In *Reg.* v. *Malony* (C. C. C. Sept. 1861), in which a man was convicted of the murder of his wife by stabbing her in the neck, the direction of the wound was not consistent with the testimony of a witness upon whose evidence the case chiefly rested. The medical witness stated that the stab followed the line of the axis of the shoulder, commencing above the collar-bone on the left side, and passed perpendicularly downwards into the chest. It caused almost immediate death. The prisoner stated that his wife had inflicted the wound on herself and had then thrown the knife away; it was found sticking by the blade upright in the floor. There was blood upon the hands of the prisoner and upon his clothes. The medical witness admitted it was possible that the deceased might have produced this wound on herself, and in answer to a question by the learned judge (Byles, J.), he thought it *probable*. At the trial, a witness came forward and swore that he saw the prisoner stab the woman, but he gave no information to the police, nor said anything about the matter. He was asked what sort of stab it was that he saw the man give to the woman. 'The witness made a *forward thrust* with his right arm;' but a wound, such as that described by the surgeon, could have been produced only by a downward thrust, the hand and arm being considerably raised. The medical witness was not further examined on this point, and on this direct testimony the prisoner was convicted of murder. It is a new feature in cases of this kind to have the question of *probability* introduced. When a medical witness has admitted that the wound may have been self-inflicted, he has gone as far as professional knowledge will admit. The question of probability must be solved, if at all, by the other circumstances of the case. In *Reg.* v. *Cogan* (C. C. C. Sept. 1861), a case in which a man was charged with the murder of his wife by cutting her throat, the wound, according to Dr. Painter, was eight inches long. It commenced at the centre of the back of the neck on the right side, passed downwards and forwards on this side of the neck across the throat to the middle of the left collar-bone. It was a very deep wound; it divided the windpipe, all the principal arteries of the neck, as well as the muscles, and even went into the cervical vertebræ. The deceased probably did not move after receiving it. A bloody razor was found six feet from the body, and there was a pool of blood near this spot, while there were marks on the window-shutter, produced by the spurting of blood from the blood-vessels, in the position in which deceased's body was lying. There were fresh cuts upon the left hand of the deceased, such as would be caused by her grasping some sharp instrument. The medical witness would not say it was impossible, but he thought it highly improbable that deceased could have produced this wound on herself. The prisoner, who had a slight wound in his throat, stated that this had been caused by his wife, who had afterwards destroyed herself. It was proved, however, that no blood had been effused at the spot where he said this wound had been inflicted by her. He was convicted. Such a wound as this could have been produced, if at all, only by the left hand of the deceased; its situation, direction, and extent, were more consistent with homicide than suicide, and the latter appears to have been clearly negatived by the facts—1, that the deceased had bled in two places, while death must have been almost instantaneous: 2, that the weapon was found at a distance from the body; and 3, that the left hand of deceased was much cut, which could be explained only by the theory that she had endeavoured to protect her throat when attacked.

The presence of several wounds.—In suicides, commonly, one wound only is seen, namely, that which has destroyed life, and the presence of several wounds on the body, or the marks of several attempts around the principal

wound, have been considered to furnish presumptive evidence of murder. But any inferences of this kind must be cautiously drawn, since not only may a murderer destroy his victim by one wound, but a suicide may inflict many, or leave the marks of several attempts before he succeeds in his purpose. A case is reported in which a gentleman, labouring under mania, attempted to destroy himself. Besides many wounds on the forearm, neck, and face, which disfigured him, there were twenty-two in front of his chest. One of these had traversed the heart, producing death after some hours, by causing effusion of blood. ('Lancet,' July 1839.) In wounds of the throat, owing either to ignorance of the situation of vital parts, or to tremulousness of the hand, a suicide often produces one or more incisions of greater or less extent near that which has destroyed life. This is especially the case when the instrument happens to lodge in the first instance on the cartilages of the larynx. The same remark applies to suicidal stabs when the point of a weapon, in being directed against the chest, comes first in contact with the ribs or their cartilages. With respect to the throat, many cases might be cited in which two, three and even six or more incisions have been made in this part by suicides before they have succeeded in destroying themselves. A case occurred to Dr. Handyside ('Ed. Med. and Surg. Jour.' Jan. 1838), in which a medical man destroyed himself by inflicting several wounds on his throat. An incision was found on each side of the neck, just below the angle of the jaw, and in the hollow behind it. They were irregular in form, and bore the character of deep stabs. The only important vessel divided was the internal jugular vein on the right side; but, nevertheless, a large quantity of blood was lost, and this was no doubt the cause of death. The case is in many points of view singular, for such wounds, so far as I know, have never before been described in cases of suicide. It would appear that the deceased was ambidextrous, and that the wound on each side of the neck was inflicted by the hand of the opposite side. The following case, which occurred in London in 1839, is somewhat similar: A lady, who had been for several days in a desponding state, was found one morning dead in her bed in a sitting posture. On examination, two very deep and extensive wounds, which had divided the principal blood-vessels, were perceived on the right side of the neck. There were two penknives on the bed covered with blood. From the situation and other characters of the wounds, it was inferred that they must have been inflicted with the left hand, although nothing satisfactory could be ascertained on this point. The husband and son slept in the adjoining room. There was no doubt that this was a case of suicide, although it is singular that two deep wounds should have been found thus inflicted by two different weapons on the right side of the neck, in the case of a person who was not known to be left-handed.

The *number* and *nature* of the wounds on these occasions generally lead to a strong suspicion of murder. In December 1859, Dr. Lucas, of Crickhowell, consulted me in the following case. A woman, æt. 60, was one morning found dead with severe wounds on the back and front of her neck, apparently made as if in an attempt at decapitation: she was seen alive three quarters of an hour before, and the only person in the house was her husband, an aged feeble man. A large table-knife newly sharpened was found near the body. When examined by Dr. Lucas, the following injuries were observed. In front there was an incised wound across the throat, four inches long, from about half an inch on the right side of the middle line towards the left ear, dividing the large muscles on the left side of the neck, and the left internal jugular vein, which was gaping. The mark of the cutting instrument was very distinct on the cartilages of the neck, extending rather obliquely down from right to left. On the back of the neck there was a deep gaping wound, extending horizontally from the right ear to the angle of the jaw on the left side, passing down

between the third and fourth vertebræ, laying the spinal marrow bare; there was a slight abrasion on the surface of the cord, which might have been accidentally produced during the examination. A second cut was found passing between the second and third vertebræ, also extending to the spinal cord. The skin showed marks of several incisions, the muscles being mangled by repeated cuttings; the edges of the bones were rough, and one slice of bone about the size of a shilling lay almost detached in the wound. The wound in front was separated from the one behind by about half an inch of skin. There were no marks of violence on the hands or on any other part of the body. The evidence at the inquest proved that the son had left the house before the time of the woman's death, and that she had spoken to the neighbours and her husband in a desponding manner a few days before the event. The evidence was generally in favour of the deed being suicidal. It was satisfactorily established that the husband and wife had lived on good terms, and no motive for his perpetrating such an act could be suggested. A verdict of 'wilful murder against some person unknown' was returned. My opinion was subsequently requested on the point whether these wounds were consistent with self-infliction, or whether they necessarily indicated an act of murder. Considering all the medical circumstances, I came to the conclusion that the wounds might have been inflicted by the deceased on herself with her left hand, probably in her attempt to cut off her head. The wounds at the back of the neck were inflicted first, while the principal wound, that which proved fatal by the division of the jugular vein, was inflicted last. The woman had been for some time in a desponding state, and on the evening before the event she had been observed by her husband to pass a knife with her left hand across the back of her neck as if she was contemplating suicide. There was not the slightest proof of homicide.

The number, situation, and direction of the wounds found on a dead body may be medically inconsistent with the theory of a suicidal origin. The following case occurred at New York in September 1839. A woman was found dead, and there were many wounds upon her body. The husband was suspected of having killed his wife, but he asserted that she had destroyed herself. This defence, however, was shown to be inconsistent with the medical facts. Three physicians who examined the body deposed that there were eleven wounds (stabs), eight on and about the left side of the thorax, one of which had penetrated the pericardium, and divided the trunk of the pulmonary artery at its origin; and the others were on the back, near the left scapula. It was considered to be quite impossible that these last-mentioned stabs could have been produced by the deceased, and there was every reason to suppose that the stabs in front and at the back had been inflicted at the same time by an assassin. In acts of murder perpetrated by lunatics or persons labouring under delirium tremens, it is usual to find a large number of wounds on the body of the person attacked. In a case communicated to me by Dr. Procter of York (June 1871), a man in a fit of delirium tremens killed his wife by cutting and stabbing her. Dr. Procter found on the body of deceased fifty-six wounds, of which some were of a nature inconsistent with the theory of self-infliction. The object with such criminals is apparently not merely to kill but to mangle the body of the victim.

The use of several weapons.—In general, suicides, when foiled in a first attempt, continue to use the same weapon; but sometimes, after having made a severe incision in the throat, they will shoot themselves, or adopt some other method of self-destruction. These cases can only appear complicated to those who are unacquainted with the facts relative to self-murder. Neither the presence of several wounds by the same kind of weapon, nor of different wounds by different weapons, can be considered of themselves to furnish any proof of the act having been homicidal. One instance has been already related, in which

a lunatic, in committing suicide, inflicted *thirty* wounds upon his head (p. 484). In a case of murder, when many wounds are found on a dead body, it may happen that the situation or direction of some will be incompatible with the idea of a suicidal origin. Thus a stab or cut may be close to a contusion or contused wound, and although a fall or other accident might account for the latter, the former would indicate violence separately inflicted.

Two or more mortal wounds.—When we find several wounds on the body of a suicide, it generally happens that one only bears about it a *mortal* character, namely that which has caused death. On this account it has been asserted by some medical jurists, that when two mortal wounds are found upon a body, and particularly if one of them is of a stunning or stupefying tendency (*i.e.* affecting the head), they must be considered incompatible with suicide. An inference of this kind can be applied to those cases only in which the two wounds, existing on different parts of the body, were likely to prove immediately fatal. It must, however, be borne in mind, that all suicides do not *immediately* perish from wounds which are commonly termed mortal: on the contrary, they have often the power to perform acts of volition and locomotion, which might by some be deemed wholly incompatible with their condition. It is difficult to say whether one wound was likely to destroy life so rapidly as to render it impossible for the person to have inflicted another upon himself; but when there are several distinct incisions on the throat, each involving important blood-vessels, there is good reason to infer that they have resulted from an act of murder. There are no rules by which, in unknown cases, the instantaneous mortality of wounds can be accurately determined—a fact which will be apparent hereafter, from a description of wounds of the head, heart, and throat.

It is not possible to say, from the mere discovery of marks of contusion or injury on the head, that the deceased must have necessarily laboured under insensibility or concussion, and have therefore been afterwards unable to inflict any other wound upon himself. Injuries of the head are attended with the most singular anomalies in this respect. One person will be rendered insensible and powerless by a blow which may leave scarcely any appreciable marks, while another will be able to walk and exert himself when the skull has been fractured and depressed, blood effused, and even when a portion of brain has been lost: in short, the appearances may be such as to induce many surgeons to express an opinion that death must have taken place instantaneously. It is quite right that a medical jurist should be fully prepared for the occurrence of such anomalous cases; but a strong suspicion of homicide may fairly exist when, besides marks of great injury to the head, a severe cut or stab is found on the body. A man is not likely to cut or stab himself after having sustained severe violence to the head; but he may retain the power of precipitating himself from an elevated spot, and thereby of producing great injury to the head, after having previously attempted to cut his throat or stab himself. ('Vierteljahrsschrift,' 1871, 2, 216).

A man was found one morning lying dead in a street in a low quarter of London, with his skull severely fractured, and his throat cut. The evidence adduced at the inquest satisfactorily showed that the deceased had attempted suicide by cutting his throat in his bed-room, and had then thrown himself out of the window, by which the fracture and other severe contusions had been produced. Had his body been thus discovered in a lonely and sequestered spot, the medical presumption would certainly have been in favour of murder. A similar remark may be made in reference to the following case, which occurred in my neighbourhood in April 1872. A man stabbed himself in the chest with a sharp instrument like a dagger, and then threw himself from a window forty feet from the ground. On examining his body the weapon was still sticking in the wound. It had penetrated the chest to the

depth of six inches. Cases of this description are usually determined by circumstantial evidence. In the following instance there could be no doubt of homicide. A woman was found dead nearly twelve months after she was first missed. Her body was clearly identified. A handkerchief was drawn tightly round the neck, and a wound from a pistol-ball was traced through the left side of the chest, passing out at the right orbit; and three other wounds were found, one of which had entered the heart, and all of which had been made by a sharp instrument. The prisoner charged with the crime alleged that the deceased had committed suicide—but the variety of the means and the instruments employed to produce death, as well as the fact that the gun-shot wound in the head, the stab in the heart, and the act of strangulation were individually sufficient to account for speedy death, left no doubt that this was an act of murder. (*The King* against *Corder*, Bury Summer Assizes, 1828. Will's 'Circ. Evidence,' p. 237.)

Wounds produced simultaneously or at different times.—When several wounds are found on a dead body, the question is frequently asked,—*Which was first received?* If one is what is commonly termed mortal, and the others not, it is probable that the latter were first inflicted. This remark applies both to cases of homicide and suicide; but it is apparent that when, in a murderous assault, a person has been attacked by several assailants at once, the wounds may have been simultaneously produced. This is, however, a question to which it is not easy to give a specific answer. Each case must be decided from the special circumstances attending it; and in most instances, unless some direct evidence is forthcoming, a medical opinion can be little more than conjectural. I here refer to it, because it is a question almost always put in a Court of law; and a witness should at least prepare himself to meet it, by a proper examination of the medical circumstances of the case.

The case of *Reg.* v. *Spicer* (Berks Lent Assizes, 1846) affords an illustration of the importance of examining wounds minutely, as well as the locality where a dead body is found, when it is suggested that death has been caused by accident. The prisoner was charged with the murder of his wife, and the evidence against him was chiefly circumstantial. The deceased was found dead at the foot of a stair, as if she had accidentally fallen backwards. The parietal bone was fractured, and the fracture had extended to the base of the skull. The brain was lacerated, and there was great effusion of blood. The second vertebra of the neck was fractured, and the spinal marrow torn through. These injuries were quite sufficient to account for death, and had they existed alone, there might have been no reason to charge the husband with the murder. But there was a recent wound on each side of the temple, partly lacerated and partly bruised, and a branch of the right temporal artery had been divided—this injury having been inflicted, apparently, with a pointed blunt instrument. There were marks of blood on the wall at the top of the staircase, and a pointed stone, covered with blood, was found near to the body. It was therefore obvious, as the deceased had fallen on the summit of the head, that the injuries to the two temples *laterally*, could not have been accidentally produced during the fall, for there was no projecting body against which she could have struck in her descent to produce them; and when the force of the fall had been spent on the head, her body could not have rolled over so as to produce punctured and lacerated wounds on both temples. All the facts tended to show that a murderous assault had been made upon her at the top of the stair, and that she had afterwards fallen or had been pitched headlong backwards. The injuries received previously to the fall might have stunned her, and might not have sufficed to account for death; but their nature and situation furnished strong proof that they could not have arisen from any accidental causes operating simultaneously, and that they were neither of accidental nor suicidal

origin. The prisoner was convicted and executed. ('Med. Gaz.' vol. 37, p. 610.)

If several wounds have been inflicted through the *dress*, an examination of this may sometimes suffice to show which was first received. A man, in struggling with an assailant, received three stabs with a knife—two on the left elbow, and the third in the back. The latter was at about the level of the eighth rib;—it was vertical to the chest, and had clean edges. The lower margin was obtuse—the upper acute; hence it was evident that the cutting edge of the weapon had been directed upwards. It had traversed the left lung and the heart, and had caused immediate death. It was obvious, on examination, that this mortal wound had been first received, and the stabs at the elbow inflicted subsequently. These two stabs, which were slight, had divided the cloth coat and shirt, and had only grazed the skin, so that no blood had been effused. But the edges of the cuts in the cloth coat and shirt were stained with blood; hence it was evident that they must have been produced by a weapon already rendered bloody by a previous wound. The fact was of some importance in the case, and the correctness of the medical opinion was confirmed by the evidence at the judicial inquiry. (See 'Ann. d'Hygiène,' 1847, 1, 461.)

CHAPTER 37.

EVIDENCE FROM CIRCUMSTANCES—MEDICAL QUESTIONS—VALUE OF CIRCUMSTANTIAL EVIDENCE—THE POSITION OF THE BODY—OF THE WEAPON—THE WEAPON OR OTHER ARTICLES FOUND IN THE HAND OF THE DECEASED—EVIDENCE FROM BLOOD, HAIR, AND OTHER SUBSTANCES ON WEAPONS—HUMAN AND ANIMAL HAIR—MARKS OF BLOOD ON CLOTHING AND FURNITURE—NO BLOOD ON THE ASSAILANT—EVIDENCE FROM WADDING AND PROJECTILES—EXAMINATION OF FIRE-ARMS—BLOOD ON THE DECEASED—BLOOD ON THE ASSAILANT—EVIDENCE FROM THE FORM AND DIRECTION OF SPOTS OF BLOOD.

Evidence from circumstances.—In pursuing the examination of the question respecting the homicidal or suicidal origin of wounds, the attention of the reader may be called to the force of evidence which is sometimes derived from the circumstances under which the body of a person, dead from wounds, is discovered. It may be said that this is a subject wholly foreign to the duties of a medical jurist, but I cannot adopt this view. There are few in the profession who, when summoned to aid justice by their science in the detection of crime, do not seek for circumstances by which to support the medical evidence required of them. A practitioner would certainly be wrong to base his professional opinion exclusively on these circumstances, but it is scarcely possible for him to avoid drawing an inference from them as they fall under his observation. His evidence may be of itself weak and insufficient to support the charge against an accused party; in such a case if any suspicious circumstances have come to his knowledge, he may be often unconsciously induced to attach greater importance to the medical facts than he is justified in doing. In short, he may, through a feeling of prejudice, which it is not always easy to avoid, give an undue force to the medical evidence. But if a proper degree of caution is used in drawing inferences, and the circumstances are not allowed to create a prejudice in his mind against the accused, a practitioner is bound to observe and record them; for, being commonly the first person called to the deceased, many facts capable of throwing an important light on the case would remain unnoticed or unknown, but for his attention to them. The position of a dead

body—the distance at which a knife or pistol is found—the direction of the instrument—whether situated to the right or left of the deceased—the marks of blood or wounds about the person, or of blood on the clothes or furniture of the apartment, are facts which may assist materially in developing the real nature of a case, and in giving force to a medical opinion. Many of these circumstances can fall under the notice of him only who is first called to the deceased; and, indeed, if observed by another, no advantage could be taken of them, except from the interpretation of a medical man.

In the case of *Davidson*, who was tried for murder before the Aberdeen Spring Court of Justiciary, April 1855, the origin of certain wounds on the head of the deceased turned on the question of the presence or absence of nails at the head of a bed. On this occasion Lord Deas, the judge, remarked: 'A medical man when he sees a dead body should notice everything.' There was reason to believe that some nails had been driven into the head of the bed subsequently to the infliction of the violence, so as to give the appearance of the wounds having resulted from accident. There was some medical evidence in support of the view of their accidental origin, but according to Dr. Ogston there was no blood on the bedstock where the nails were represented to have been: and as the woman had died from bleeding, this was not likely to have escaped being stained with blood, if the wounds, as alleged for the defence, had really been produced by the nails. In his opinion, too, the nails would not have accounted for the wounds on the temple as the result of any accident. The whole of the difficulty in this case appears to have arisen from want of proof that there were no nails in the bedstock when the woman was found dead. The prisoner was discharged on a verdict of 'not proven.'

Among the questions which present themselves on these occasions are the following:—Is the position of a wounded body *that* which a suicide could have assumed? Is the distance of a weapon from the body such as to render it improbable that it could have been placed there by the deceased?—In answering either of these questions, it is necessary to take into consideration the extent of the wound, and the time at which it probably proved fatal. Again, it may be inquired—Has the deceased bled in more places than one? Are the streams of blood all connected? Are there any marks of blood on his person or clothes, which he could not well have produced himself? Are there any projecting nails or other articles which might account for wounds on the body as the result of accident? These are questions, the answers to which may materially affect the case: hence a practitioner, in noticing and recording the circumstances involved in them, ought to exercise due caution. 'The consideration of the nature of circumstantial evidence,' observes Starkie, 'and of the principles on which it is founded, merits the most profound attention. It is essential to the well-being at least, if not to the very existence of civil society, that it should be understood that the secrecy with which crimes are committed will not insure impunity to the offender. At the same time it is to be emphatically remarked that, in no case and upon no principle, can the policy of preventing crime and protecting society warrant any inference which is not founded on the most full and certain conviction of the truth of the fact, independently of the nature of the offence and of all extrinsic considerations whatever. Circumstantial evidence is allowed to prevail to the conviction of an offender not because it is necessary and politic that it should be resorted to, but because it is in its own nature capable of producing the highest moral degree of certainty in its application. Fortunately for the interests of society, crimes, especially those of great enormity and violence, can rarely be committed without affording vestiges by which the offender may be traced and ascertained. The very measures which he adopts for his security not unfrequently turn out to be the most cogent arguments of guilt. On the other hand, it is to be recollected

that this is a species of evidence which requires the utmost degree of caution and vigilance in its application, and, in acting upon it, the just and humane rule impressed by Lord Hale cannot be too often repeated: 'tutius semper est errare in absolvendo quam in puniendo, ex parte misericordiæ quam ex parte justitiæ.' Admitting the truth of all that is here stated, it must be remembered that in some of the foulest murders the testimony of eye-witnesses has not been, and cannot be, forthcoming. 'Murders,' observes Lord Deas (case of *McLachlan*, Glasgow, 1862), 'are not committed before people's eyes; and if it were necessary to have direct evidence of murder, it would be very easy to murder anybody without detection, and we might have a murder committed with impunity every day. That is not the law, and I do not think you (the jury) will be of opinion that that should be the law. The law is that facts and circumstances (whether medical or non-medical) put together may be so strong as to prove murder.' The facts and circumstances, of course, when thus put together, should admit of no reasonable doubt. Evidence is *direct* when a fact is proved by eye-witnesses, and *circumstantial* when the fact is proved by circumstances. More commonly it is *presumptive*, *i.e.* founded on an inference from circumstances.

The rule respecting the admissibility of this kind of evidence applies to circumstances of a *medical*, as well as those which are of a physical or moral kind. Medical circumstances, when properly observed and interpreted, are often of the highest importance. In order to convict an accused person on circumstantial evidence, the facts proved in the case should be consistent with his guilt, and be utterly inconsistent with his innocence; or, in the language of a learned judge, a certain number of material facts should be incontestably proved in the case, which are quite inconsistent with the innocence of the prisoner. These facts should be such as to render it impossible in the minds of the jury that any one but the prisoner could have committed the murder. The late Baron Alderson, in charging a jury to this effect, made an observation which should be remembered by medical witnesses, in reference to circumstantial evidence. He pointed out to them the 'proneness of the human mind to distort the facts in order to establish such a proposition (the guilt of the prisoner), forgetting that a *single circumstance* which is inconsistent with such a conclusion is of more importance than all the rest, inasmuch as it at once destroys the hypothesis of guilt.'

There are many cases on record in which an observation of slight and unexpected circumstances by medical men, has led to the detection of offenders. In the life of Sir Astley Cooper, it is mentioned, that when called to see *Mr. Blight*, of Deptford, who had been mortally wounded by a pistol-shot in the year 1806, he inferred from an examination of the localities that the shot must have been fired by a *left-handed* man. The only left-handed man near the premises at the time was a Mr. Patch, a particular friend of the deceased, who was not in the least suspected. This man was, however, subsequently tried and convicted of the crime, and he made a full confession of his guilt before execution.

The rules for investigating a case of poisoning (see p. 202) may be equally observed in cases of death from violence. Among the circumstances to which a medical witness should specially direct his attention on these occasions are the following:—

1 *The position of the body.*—The body may be found in a position which the deceased could not have assumed on the supposition of the wound or injury having been accidental or suicidal. The position of a dead wounded body is often only compatible with homicidal interference, either at the time of death or immediately afterwards. In order to determine the probable time of death, we should always notice whether there is any warmth about the body—whether

it is rigid, or in a state of decomposition, and to what degree this may have advanced. The importance of such observations in a case of alleged murder has been elsewhere considered (pp. 70–83).

2. *The position of the weapon.*—If a person has died from an accidental or self-inflicted wound, likely to cause death either immediately or within a few minutes, the weapon is commonly found either near to the body or within a short distance of it. If found near, it is proper to notice on which side of the body it is lying; if at a short distance, we must consider whether it might have fallen to the spot, or have been thrown or placed there by the deceased. If there has been any interference with the body, evidence from the relative position of it and the weapon will be inadmissible. In a case which was referred to me some years since, a woman had evidently died from a severe wound in the throat, which was homicidally inflicted; the weapon, a razor, was found under the left shoulder, a most unusual situation, but which, it appears, it had taken owing to the body having been carelessly turned over before it was seen by the surgeon who was first called.

It is compatible with suicide that a weapon may be found at some distance, or in a concealed situation; but it is much more frequently either grasped in the hand, or lying by the side of the deceased. In one instance, it is stated the deceased was discovered in bed with his throat cut, and the razor lying *closed* or shut by his side. In another case, the bloody razor closed was found in the deceased's pocket. In the case of a *Captain Wright*, who was found dead in one of the French prisons (during the war with France), it is stated on good authority that the *razor shut* was held in the hand of the deceased. In a wound involving the great blood-vessels of the neck, it is most improbable that there should be any power to close or shut the razor with which the wound was inflicted; and there are fair grounds to suspect interference when a razor is thus found closed in the hand. There is, however, one circumstance in relation to a weapon strongly confirmatory of *suicide*. If the instrument is firmly grasped in the hand of the deceased, no better circumstantial evidence of suicide can be offered. It is so common to find knives, razors, and pistols grasped in the hands of suicides, that it is quite unnecessary to produce cases illustrative of this statement. The grasping of a weapon appears to be owing to muscular spasm persisting after death, and manifesting itself under the form of what has been called cadaveric spasm—a condition quite distinct from rigidity, although often running into it. It does not seem possible that any murderer could imitate this state, since the relaxed hand of a dead person cannot be made to grasp or retain a weapon, like the hand which has firmly held it by powerful muscular contraction at the last moment of life. Of this the cases of *Reg.* v. *Saville* (Nottingham Summer Assizes, 1844) and *Reg.* v. *Heywood* (Liverpool Winter Assizes, 1855), furnish illustrations. See pp. 68, 491.

In reference to the weapon being found at a distance from the body, all the circumstances of the case should be taken into consideration before any opinion is expressed. If the weapon cannot be discovered or it is found concealed in a distant place, this is strongly presumptive of homicide, provided the wound is of such a nature as to prove speedily fatal. In the case of *Lord W. Russell*, 1840, no weapon could be found; and although the wound in the throat bore somewhat of the characters of a suicidal incision, the absence of the weapon was sufficient to show that a wound which was certain to be rapidly fatal must have been the act of a murderer. The assassin had used a carving-knife, which he had afterwards washed and then replaced in the tray with the other knives.

It will be proper to notice whether the weapon is sharp or blunt, straight or bent, also whether the edge is or is not notched. These circumstances may throw a light on the question of suicide or murder. In *Reg.* v. *Gill* (Dublin Commission Court, Nov. 1860), the prisoner, an old man, was charged with the

murder of his wife. The woman was found dead with a wound in her throat which divided the larynx at the thyroid cartilage as well as the thyroideal arteries and gullet. It penetrated to the front of the spine, which was hacked and notched apparently with some violence. Several pieces of bone were detached. The right hand of the deceased was turned back, and a blunt knife was lying loosely in it, not grasped. The cut through the skin and muscles of the throat was clean and had evidently been made by a sharp instrument. On the left side the cut had two extremities presenting an appearance as if the weapon had been twice used in cutting. The knife found in the hand of deceased was not only blunt, but turned at the point, and it had no handle. There was a mark of a bloody finger on the dress over the left shoulder of deceased. From this state of facts, Mr. Porter and the late Dr. Geoghegan drew the conclusion that deceased had not inflicted this wound on herself. Among other circumstances the hacking of the spinal column and the evidence of two separate cuts were adverse to the theory of suicide. Further, the wound had not been made with the knife found in the hand. If this weapon had been used for the purposes of suicide, it would either have been grasped in or have altogether fallen out of the hand. The deceased had not produced the bloody mark of a finger found upon her dress. These conclusions were fairly justified by the facts. A blunt knife had been substituted for a sharp razor; the placing the knife in the hand had failed to give the appearance presented in suicide, and the nature of the wound was inconsistent with the idea of self-infliction. The prisoner was nevertheless acquitted.

3. *Blood on weapons.*—The weapon with which a wound has been inflicted is not necessarily covered with blood. The popular view is that if much blood is found about a dead body, the weapon ought always to be more or less bloody. In reference to heavy blunt instruments applied with force to the head, severe contusions and fractures may be produced without immediate effusion of blood. Unless the bludgeon is used in a subsequent struggle or handled by a bloody hand, no blood whatever may be found on the end which produced the injuries. In reference to stabs, the knife is frequently without any stains of blood upon it, or there is only a slight film, which on drying gives to the surface a yellowish-brown colour. The explanation of these facts appears to be that in a rapid blow or plunge the vessels are compressed, so that bleeding takes place only after the sudden withdrawal, when the pressure is removed. Even if blood should be effused, (the weapon, in being withdrawn, is sometimes cleanly wiped against the edges of the wound, owing to the elasticity of the skin.) Thus the first stab through the dress may not present any appearance of blood on the outside, but in a second stab with the same weapon the outside of the dress should present a bloody mark, unless the weapon had previously been wiped (p. 503). The blood may have been removed by washing from the blade of a knife or dagger. The handle and inner portions should therefore be closely examined. In a case of alleged murder (Nov. 1857) I found no blood on the blade of a knife or in the notch for opening it; but on removing the buckhorn handle I found a coagulum of blood between this and the plate of iron to which it was riveted.

When a weapon is bloody, particular attention should be given to the manner in which the blood is diffused over it. In cases of imputed wounds, or in the attempted concealment of murder, it is not unusual for a criminal to besmear with blood a knife or other weapon which has probably not been used, and to place it near the body. A young man alleged that he had received a cut on the forehead by a blow from a cutlass, which he produced. It was observed by the late Dr. Marc that the weapon was smeared with blood on both surfaces, but the layers were thicker towards the handle than at the point. The wound on the forehead was a clean incision; a cap, which the complainant

wore, had been cut through. It was obvious, therefore, that the blood on the weapon could not have proceeded from this cut, for it would have been wiped, or only left in thin streaks, and more towards the point than the handle, by the act of drawing it through the clothes in producing the wound. There was no doubt that blood had been intentionally applied to this blade. ('Annales d'Hygiène,' 1829, 1, 263.) In the case of *Doidge* (Cornish Summer Assizes, 1862), the weapon, a large cleaver, had been wiped on the smock of the deceased, but although the blood had been thus in great part removed from the surface of the blade, it had been wiped into the recesses of the letters of the maker's name, which were found to contain dry coagulated blood.

The blood on a weapon may be wet or dry in a partly coagulated state, or diffused as a mere film. If coagulated this would render it probable that it had issued from the body of a living person or animal, or from a body recently dead. The blood of a *dead* animal dried in small spots on the blade of a knife may sometimes present a similar appearance, and thus lead to a mistake in evidence. This question arose in the case of *Reg.* v. *Nation* (Taunton Spring Assizes, 1857). Deceased was found dead in a cart with his throat cut, and there could be no doubt that this was an act of murder. The prisoner, who had been last seen in his company, was arrested, and a knife was found in his possession, on the blade of which there were marks of blood. On the part of the prosecution, it was contended that the knife had been used for cutting the throat of the deceased, while, according to evidence given for the defence, it had been used for cutting raw meat (beef). A chemical witness, who was called for the prosecution, stated that the knife had been immersed in *living* blood up to the hilt—that it was *not* the blood of an ox or a sheep, and that there were on the blade of the knife certain scales or empty cells, such as are found in the mucous membranes of the throat (epithelial scales?). They were much larger than the globules of the blood, and were perfectly distinguishable by the microscope. From the appearance he thought the knife had passed through the mucous membrane which forms the lining of the throat! If this evidence was trustworthy there was an end of the defence; with the admission of the statement that there were scales of the mucous membrane of the *throat* (the gullet?) upon the blade, no further proof was required that the weapon had been used for cutting a throat. Fortunately, however, for the ends of justice, there were other circumstances which brought the crime home to the prisoner, and he was convicted. ('Med. Times and Gaz.' April 11, 1857.) Cockburn, C.J., in commenting on these microscopic subtleties, said, 'In admitting the advantages of science, they were coming to great niceties indeed when they speculated upon things almost beyond perception, and he would advise the jury not to convict upon this scientific speculation alone.'

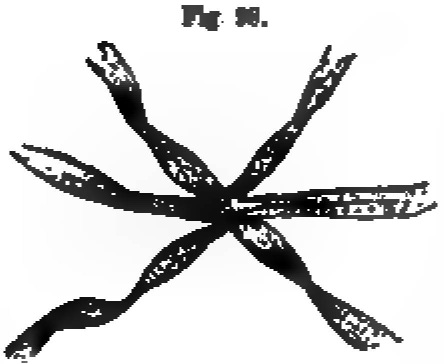
4. *Hair and other substances on weapons.*—In some instances no blood may exist on a weapon, but a few hairs or fibres may be found adhering to it if the weapon is of a bruising or cutting kind. The main question may be in such a case whether the fibres are of cotton, linen, silk, or woollen, and whether the hair is that of a human being or of an animal. The importance of examining closely the hair found on weapons is shown in a case quoted by Dr. Lyons, in which a hatchet having clotted blood and hair adherent to it was produced as evidence against an accused person, under whose bed this weapon had been found. This, with other circumstantial evidence, had turned public opinion strongly against the prisoner; but when the hair was examined it was found not to be human, but to have been taken from the body of some animal. This circumstance led to a more complete sifting of the evidence, and the accused was acquitted. It turned out that the accused had killed an animal with the hatchet, and had carelessly thrown the weapon under the bed. ('Apology for the Microscope,' p. 24.) In *Reg.* v. *Hansen* (Bodmin Lent Assizes, 1856), the

weapon by which the deceased lost his life was a heavy stone found near the dead body. The base of the skull was fractured, and there were upon the stone marks of blood with some hair similar to that of the deceased. The prisoner was connected with the act by his having been seen with the stone, or one closely resembling it, in his possession. On these and other circumstances he was convicted.

Before any coagulated blood is removed from a weapon it should be examined carefully by the microscope. Hairs or fibres of linen, woollen, silk, or cotton may be found imbedded in the solidified blood, either on the edge or on the blade; and evidence of this kind may occasionally be of great importance. In *Reg.* v. *Harrington* (Essex Lent Assizes, 1852), a razor was produced in evidence, with which it was alleged the throat of the deceased had been cut. I examined the edge microscopically, and separated some small fibres from a coagulum of blood, which, under a high magnifying power, turned out to be cotton fibres. It was proved at the trial that the assassin, in cutting the throat of the deceased while lying asleep, had cut through one of the strings of her cotton nightcap. This was a strong circumstance to show that the razor produced was the weapon with which the fatal wound had been inflicted.

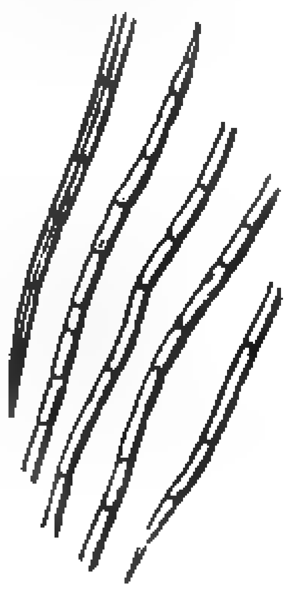
In *Reg.* v. *Steed* (Maidstone Summer Assizes, 1863), Dr. Pavy and I examined the boots of the prisoner who was charged with the murder of the deceased. The marks of violence about the head showed that the assailant had trampled on the deceased after he was on the ground, producing severe wounds which led to his death. Some hairs were found firmly wedged beneath the large hobnails of the boots, and in certain dark stains of coagulated blood on the leather there were some red woollen fibres. The hair was compared with a portion cut from the head of the deceased, and corresponded in colour and size. On inquiry it was found that at the time of his death deceased wore round his neck a red woollen comforter, of which the wool corresponded in colour and appearance with that taken from the prisoner's boots. The case was brought home to the prisoner by a variety of circumstances, all inconsistent with his innocence. I have elsewhere referred to the case of Cass (*Reg.* v. *Cass*, p. 489), in which the dried blood upon a knife lying near the body of deceased was found, on a microscopical examination, to lock up within it cer-

Fig. 98.



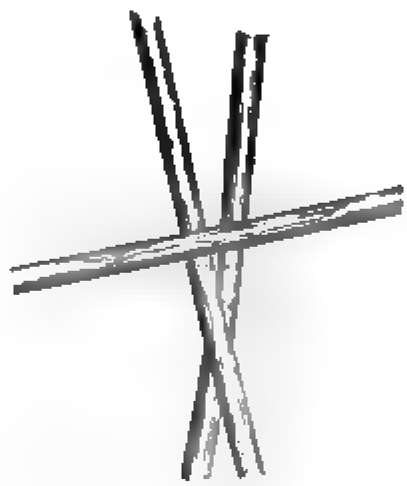
Fibres of Cotton, magnified 300 diameters.

Fig. 99.



Fibres of Linen, magnified 300 diameters.

Fig. 100.



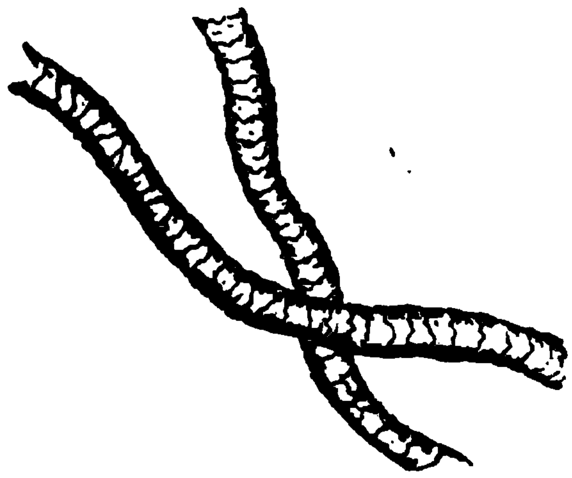
Fibres of Silk, magnified 300 diameters.

tain fibres of woollen of a peculiar dark dye, resembling the fibres taken from a coat worn by the prisoner.

Fibres found upon weapons should, if adherent to coagula, be removed by

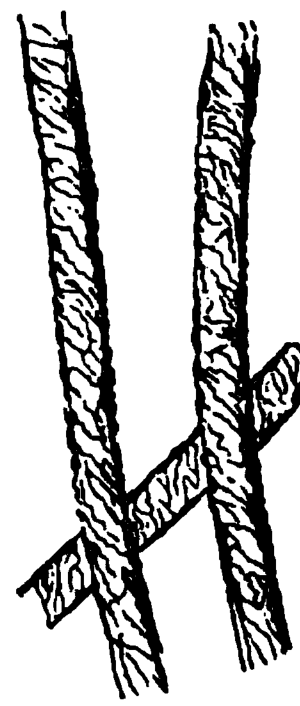
careful digestion of the clot of blood in water, otherwise they may be at once examined in the dry state. A magnifying power of about 300 diameters may be employed. Under these circumstances *cotton* presents itself as a flattened

Fig. 101.



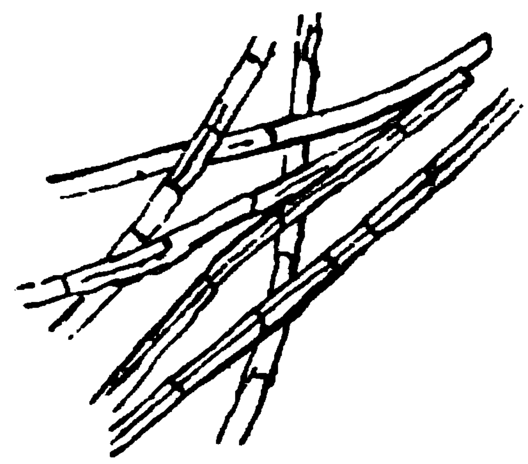
Fibres of Woollen, magnified 300 diameters.

Fig. 102.



Fibres of ancient Woollen, magnified 300 diameters.

Fig. 103.



Fibres of ancient Linen, from an Egyptian Mummy, magnified 300 diameters.

band, assuming more or less a spiral form (fig. 98, p. 509). The fibre of *linen* derived from flax is of a rectilinear form, with jointed markings at unequal distances, the fibre tapering to a point (fig. 99). Silk and woollen have other characters by which they may be identified. *Silk* presents a regular cylindrical form, and there are no markings upon the surface. It has a strong refracting power on light, which gives to the fibre a well-defined boundary (fig. 100). The fibre of *woollen* is irregular, contorted, of unequal thickness, and it has peculiar markings of an imbricated character on the surface (fig. 101). This may be taken as the type of cloth, shoddy, alpaca, merino, and a variety of other fabrics worn as clothing. The microscopical characters of these fibres under certain circumstances are long retained, so that they may be identified after many centuries. Fig 102 represents the woollen fibre from the shroud of a monk buried in an ancient priory in the fourteenth century, and exhumed within a recent period, after the lapse of five hundred years. The markings are simply less defined than in the recent sample of wool. The fibres are also of a coarser and larger kind. The fibre of linen appears to be equally indestructible. Fig. 103 represents fibres from the linen cerements of a mummy, of the dynasty of the Shepherd Kings. It was unrolled in 1832. This fibre is well preserved, and is still tough. The ancient woollen is rotten, and breaks into small fragments. The linen has the characters of the fibre of modern flax. It is of a very coarse fabric, and is strongly impregnated with a brown bituminous matter used in embalming. Its preservation is no doubt in great part owing to the presence of this substance. The illustrations above given have been drawn from average specimens, under the same microscopical power, so that they are calculated to give an idea of the relative size of the fibres. (See on this subject Linde's 'Beiträge zur gerichtlichen Chemie,' p. 45, 1853.)

Other fibres are frequently found upon weapons, boots, and articles of dress. These are common vegetable fibres from roots, leaves, and other substances. They cannot be confounded either with hair or with the four sorts of fibres above described. The discovery of *hairs* upon weapons or clothing may have an important bearing on medical circumstantial evidence. The character of human hair is pretty well marked at all ages. In the young and in females it

is long and fine. The hair of the head presents itself in transparent cylinders, variously coloured, with markings resembling those of wool, but hair is more uniform in width. It has a cortical and medullary portion. In the annexed illustration Fig. 104, No. 1, represents the hair of a child, magnified 300 diameters, with the linear markings on the cortical portion. No 2 represents the hair of an adult, magnified 300 diameters. The lines are equally seen on the cortical portion—the dark shading in the centre represents the situation of cells which traverse the centre of the medullary portion. The letter *a* represents the transverse section of the hair, showing the cortical and medullary portion, and the air-cells in the centre of the cylinder. These hairs were found on measurement to have a diameter of 1-360th of an inch. Human hairs vary much in size—some do not exceed the 1-600th of an inch. No. 3 represents the pointed extremity of the hair of the eyebrow. These hairs, like those of the eyelashes, are coarser and thicker than those of the head, and are opaque, except near the point, where they become transparent, as shown in the illustration. In examining hairs microscopically it will be well to observe whether they are of the same or of different colours or sizes, whether they are pointed at one end or cut at both ends, and whether they have still attached to them the bulb or sheath in which they grew. The annexed engraving, Fig. 105, No. 4, represents the sheath of the hair with the hair issuing from it. This condition of the hair will be found when it has been violently torn from the skin. The microscope will sometimes enable a medical jurist to state whether a hair has been indented, cut, or bruised, at either or both ends—the medullary structure frequently retains these marks of violent treatment. (See Casper's 'Vierteljahrsschrift,' Jan. 1863, p. 76.) The hairs of animals are frequently found on weapons and clothing: they must not be confounded with human hair. They are generally speaking coarser, shorter, thicker, and less transparent than those of a human being. The hair of some animals may be at once distinguished by the eye or by a pocket lens, as that of the cow, the horse, and the deer; but the hair of some dogs, such as the Skye-terrier and spaniel, closely resembles that of man. It is long and silky. The linear markings on the cortical portion are not so numerous or fine. Fig. 106, No. 5, is the hair of a spaniel magnified 300 diameters. By measurement it had a diameter of the 1-1125th of an inch. No. 6 is the hair or fur of the rabbit, 1-1125th of an inch. No. 7 the hair of the hare. These hairs have a remarkable structure, in the form of dark transverse cells. This kind of hair is found in all the rodentia, *i.e.* the rat, the mouse, and the squirrel. No. 8, the hair of the horse, 1-340th of an inch. No. 9, of the goat, 1-500th of an inch. No. 10, of the fox, 1-600th. No. 11, of the cow, 1-600th of an inch. No. 12, the hair of the fallow-deer, 1-250th of an inch in diameter. The mere difference in size among these hairs is not to be regarded as a marked distinction, for in the same animal hairs of very different sizes may be found. The engravings above given have been accurately copied from actual specimens measured at the time of observation. They

Fig. 104.

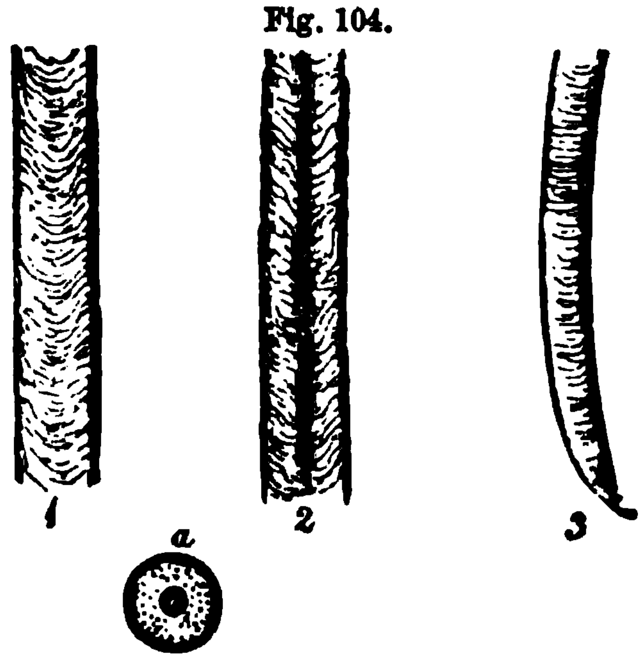


Fig. 105.

Human Hair, with tubular Sheath, as torn out by force, magnified 70 diameters.

are all represented under the same magnifying power, *i.e.* 300 diameters. The cells and linear markings on the cortical portion furnish the most striking differences. The necessity for an acquaintance with the characters of hair will

Fig. 106.

be apparent from the case of Teague (*Reg.* v. *Teague*, Cornwall Summer Assizes, 1851, p. 476), and of Watson (*Reg.* v. *Watson*, p. 513). In Teague's case it was alleged that the fatal wounds to the head of deceased, involving both eyebrows, had been produced by a hammer found on a hedge. There was no blood on the hammer, but there were two short white stiff hairs at the smaller end. It was suggested that these might have been the hairs of a white goat, the hammer having been used for beating out portions of goat-skin which were hanging on the same hedge. Two medical witnesses, however, deposed that they were hairs from a human eyebrow, and having compared them with the deceased's eyebrow, they found they agreed. The hair of the eyebrow was described as conoidal or pyramidal: and the hair on the hammer had this character. It appeared as if it had been bruised or squeezed between two blunt substances, but this appearance might have been equally presented on the theory of the defence, that it was goat's, and not human hair. Assuming the medical evidence to be correct, it pointed to the weapon, and not to any act on the part of the prisoner. The witnesses were severely cross-examined upon the structural differences of the hair of man and animals. ('Med. Gaz.' 1851, 48, 781.)

It will easily occur to a medical jurist that, on some occasions, this kind of evidence may be of importance in showing that the hair is similar to or different from that of the assailant or deceased. An opinion of identity based on a similarity of hairs found on a weapon or on a person who has died from violence, should be expressed with caution. The hair of a woman is generally longer, finer, and more curled than that of a man, and the hair in children is finer and more silky-looking than that of an adult. But there are many persons who have hair similar in colour, size, and length; hence a witness may be able to say that there was similarity, but he can rarely be in a position to swear that there is absolute identity. In *Reg.* v. *Devine*, March 1864, the deceased was killed by blows with a poker. On the end of the weapon, which was traced to the prisoner, some grey hairs were found, corresponding to those of the deceased. In a case of murder and suicide which occurred at Somers Town in July 1864, Dr. Harley found on a hatchet certain hairs from one to three-and-a-half inches long, which he described as human hairs from the head of a fair person who was becoming grey. From their fineness he considered them to be hairs from the head of a woman, and when compared with those taken from the head of the deceased woman (*Rosetta Bishop*), they presented so great a similarity as to leave no doubt that the hair had belonged to the same person, and that the wounds on the head had been inflicted with this hatchet. As in other cases of contused wounds on the head, there was no blood upon

the hatchet. The presence of hairs on a weapon under these circumstances proves that it has not been washed, or they would not be found; and if with the hairs there is no blood, then it follows that these could not have been stained with blood from the wound. This absence of blood is, however, quite consistent with the production of contused wounds from which blood may have subsequently escaped in large quantity. (See page 507.)

The discovery of the hair of animals may sometimes have an important bearing on a case, as in *Reg.* v. *Watson and wife* (Notts Lent Assizes, 1867). The prisoners were charged with the murder of a man named *Raynor*. He was seen going into the prisoners' house, and about two hours afterwards his dead body was found lying across a line of railway below it. Twenty minutes before the body was discovered, a person had passed the spot, and the body was not there. The medical evidence showed that death had been caused by manual strangulation. There were marks of bruises about the head. The face was smeared with blood, and blood had escaped from the nose, but there was no wound by cutting and no great blood-vessel had been injured. No hat could be found. There were marks of dragging between the cottage and the line of railway, and at one part in the soft clay there were the impressions of footmarks corresponding to the boots of the male prisoner. On the top bar of a gate there were marks of blood. On searching the house an iron-rake was found concealed on a shelf. This was delivered to me for examination. A cindery substance adhered to one end of it, looking as if it had undergone fusion. On heating a portion of it the smell of burnt shellac was emitted, and on acting on it with alcohol a resinous solution like that of shellac was obtained. The alcohol caused the separation of some fibres which under the microscope proved to be the hair of some animal of the order rodentia. The annexed engraving (Fig. 107) represents the appearance presented. The short fibres were mixed with irregular flakes of resin (shellac) only partially destroyed. On being questioned respecting the rake the male prisoner said he himself had used it on the Friday (the day before the murder) for cleaning out a cess-pool.

Fig. 107.

Portions of Rabbit's Fur and flakes of Resin, separated from an iron rake, magnified 134 diameters. Case of Raynor (*Reg.* v. *Watson*).

A hat similar to that worn by the deceased, and purchased at the same shop, was burnt. The cindery ash was collected, and submitted to examination with precisely similar results. These hats are made of felt chiefly from rabbit's and hare's fur, and this is combined with a quantity of shellac.

The theory of the prosecution was that deceased had been killed by the prisoners in their house; that they had afterwards taken an opportunity of dragging the dead body from the cottage to the railway line, and had laid it across the rail, with a view of its being run over by an expected train, and the murder thus concealed. The train then due was late that day, and the body was discovered and removed by the porter before it had passed. Where was the hat of the deceased? It was a worthless article which no one perpetrating murder would have stolen, to be perhaps a proof against him, and yet no hat was found with the body. It was suggested for the prosecution that in dragging down the body, the hat was accidentally left in the cottage. To have returned with it to the railway might have led to detection. It was assumed that the prisoners had burnt it under the grate in order that it might not be evidence against them, and that they used the rake

in the process by pressing it together, and thus some portion of the half-burnt felt still adhered to the flat end of the rake.

It was suggested in the defence that the rake might have been used for the burning of a hat a long time previously, and that the burnt shellac or resin adhering to the rake, might have been used by somebody for making varnish. This was obviously no answer. According to the statement of one of the prisoners, the substance found on the rake could not have been there more than twenty-four hours, *i.e.* within the time which included the murder of Raynor. Admitting that shellac or resin is used in making varnish, rabbit's fur is not so employed, and it was necessary to account for the presence of both of these substances on the cottage-rake. There was no evidence to show that there had been varnish-making and the burning of rabbit-skins in this cottage within twenty-four hours of the death of Raynor. The only conclusion to be drawn from the facts was that some one for some purpose or other had within the time mentioned burnt in the prisoners' cottage a hat similar to that worn by the deceased, and that the prisoners knew nothing of the proceeding. Had this case occurred in Scotland it might have had a different termination. There the accused are under proper restrictions interrogated, and if really innocent they are at once enabled to give an explanation of any suspicious circumstances.

5. *Foreign substances in wounds.*—In gunshot wounds, the examination of wadding or paper found in a wound or near a dead body, has in more than one instance led to the detection of the person who had committed a crime. His handwriting has been traced on the paper used as wadding, or it has been found to have been part of a printed page, of which the remainder has been discovered in his possession. When a gun is discharged near to the body, a portion of the wadding is generally carried into the large irregular wound which is produced. This was part of the evidence in the case of *Reg.* v. *Blagg* (Chester Summer Assizes, 1857). The peculiar character of the wadding found in the body connected the prisoner with the act. Whether the wadding is found in or near the body, it should be equally preserved. In *Reg.* v. *Richardson* (Lincoln Assizes, Dec. 1860), the accused was convicted of murdering a policeman under the following circumstances. He shot at the deceased, who was able before death to identify the prisoner; but as the deceased was weak from loss of blood and failing in consciousness at the time, there was some difficulty in relying upon this dying declaration, especially as no other person witnessed the act. Some paper-wadding had been picked up on the spot where the deceased fell; and a gun which had one barrel loaded, and one empty from a recent discharge, was found in the prisoner's house within twenty-four hours of the murder. The wadding in the loaded barrel consisted of a fragment of *The Times* newspaper of the 27th of March 1854, and the charred and sulphurous pieces of wadding picked up on the spot were proved by the publisher of that journal, who was summoned on the trial, to have formed a portion of the same impression. The prisoner's counsel, in fact, though he contended with marked ability for the innocence of the prisoner, could not deny that the act had been brought home to the instrument if not to the agent, and though the explanation of the crime remained obscure to the last and the motive unassignable, the aggregate evidence proved sufficient to convince the jury. Any projectiles found in a gunshot wound should always be preserved for evidence. In the case of *Rush*, who was tried and convicted of the murder of *Mr. Jermy* by a remarkable train of circumstantial evidence (Norwich Lent Assizes, 1849), it was proved that the projectiles removed from the body of the deceased consisted of irregular pieces of lead (slugs). Similar masses were taken from the body of the son, who was killed at the same time. They were described by the medical witness as being angular, and quite unlike the shot used in killing game. Each piece weighed from eleven to thirteen grains, and there were

fifteen pieces in all. As the learned judge remarked, this demonstrated that the two acts of murder were committed by the same person, or by this person acting in concert with others. In the *Queen* v. *Lloyd* (Shrewsbury Lent Assizes, 1854), it was proved that the deceased had been killed by the discharge of a gun through a window. He was struck on the head by about thirty shots, one of which had penetrated the brain and caused death. The assailant was not seen, but the charge was brought home to him by numerous circumstances: among others by the discovery in one of his pockets of shot of the same sizes as those removed from the head of the deceased (Nos. 3 and 4). The surgeon had very properly removed and preserved the shot, so that they were afterwards available as evidence against the prisoner. Facts of this kind may sometimes establish the innocence of suspected persons. In August 1859, a man was shot at Sheffield while sitting in a room. He was wounded in the left temple, and the ball lodged behind the left eye. A man was arrested on suspicion, and on searching his house two pistols were found, one a small one, and the other several sizes larger. As the ball could not be removed, and the wounded man survived, no comparison could be made. In the meantime the prisoner was remanded. The wounded person died in March 1860, from the effects of the injury. The ball was then extracted from the body and compared with the pistols. It was too small for one and too large for the other, so that it could not have been fired out of either. The man was discharged.

The chemical analysis of a projectile may be occasionally necessary. A common bullet is entirely formed of lead. Cast bullets are commonly found to have a void space in the interior when cut through the centre, owing to the exterior cooling more rapidly than the interior, and to the greater bulk of the metal when in a liquid state. In large bullets this cavity is frequently of the size of a barleycorn. Bullets obtained by compression have no such space, and are of greater specific gravity. Small-shot consist of lead with a minute fractional portion of arsenic (1-200th part). If the arsenic is in large proportion the shot is lenticular; if absent or in small proportion, pyriform (Ure). In the case of *Rush*, type-metal was found in the house. This consists of lead with one-fourth part of antimony, the latter being left by digestion in nitric acid. It was therefore considered advisable to examine the slugs chemically, and they were found to consist chiefly of lead, and to contain no antimony.

Examination of Fire-arms.—An attempt has been made by French medical jurists to determine for how long a period a gun or pistol found lying near a dead body may have been discharged; but it is out of our power to lay down any precise rules on such a subject. All that we can say is, a quantity of sulphide of potassium, mixed with charcoal, is left adhering to the barrel of the piece when *recently* discharged; and this is indicated by forming a strong alkaline solution with water, evolving an odour of sulphuretted hydrogen, and giving a deep-brown precipitate with a solution of acetate of lead. After some hours or days, according to the degree of exposure to air and moisture, the saline residue becomes converted into white sulphate of potash, forming a neutral solution with water, and giving a white precipitate with acetate of lead. If a considerable time has elapsed since the piece was discharged, oxide of iron with traces of sulphate may be found. (See 'Ann. d'Hyg.' 1834, 1, p. 458; 1839, 1, p. 197; 1842, 1, p. 368.) This subject excited some attention at a trial which took place in France in reference to the death of *M. Dujarrier.* It was considered here of some importance to determine whether, by the mere discharge of powder, such a deposit of charcoal or powder took place at the mouth of the pistol as to soil the finger when introduced three hours after the alleged discharge. M. Boutigny conducted the investigation, and found in his experiments that the finger was not blackened under the circumstances. He considers that sulphate and carbonate of potash are rapidly formed, and that

the charcoal is entirely consumed. The facts proved at the trial were, however, adverse to the view thus taken; and it really appears that this most elaborate inquiry, involving physics, chemistry, and mathematics, might have been spared on the simple ground that the result produced by a discharge of powder in the way supposed, must depend on the quantity of powder employed, its perfect or imperfect combustion, and the proportion of charcoal contained in it. The elements for solving such a strange pyrotechnic question must therefore in most, if not in all cases, be wanting. ('Ann. d'Hygiène,' 1848, 1, 392.)

Foreign substances are sometimes discovered in contused or lacerated wounds: and these may throw an important light on the circumstances under which a crime has been perpetrated. In *Reg.* v. *Hazell* (Taunton Lent Assizes, 1848), the body of the deceased was found in a well. When examined, there were on the head several severe wounds quite sufficient to account for death. There was much blood on the clothes and face, and in the blood were sticking a quantity of hay-seeds, which led the medical witnesses to consider that the wound must have been inflicted in a stable, or in some place where there was hay. On examining a neighbouring stable, the spot where the murder was committed was rendered evident by the discovery of marks of blood. There may be found in the wound a portion of the weapon itself. The preservation of this is necessary, as it may serve to connect the prisoner with the act, should his criminality be otherwise doubtful. In *Reg.* v. *De Salvi* (C. C. C., October 1857), it was proved that the deceased died from a stab inflicted on him by the prisoner. Two inches of the pointed portion of the blade of a knife were found imbedded in one of the vertebræ. The spinal cord had been divided, and paralysis ending fatally was a result of the wound. The identity of the weapon was not only established, but the force by which it had been used by the prisoner was thus clearly indicated.

In the case of a man named *Moore*, charged with murdering his wife in Finsbury, in December 1859, it was proved that the woman's throat had been cut through to the spinal column. The surgeon in making a minute examination of deceased's neck, found imbedded in the muscles and bones small particles of steel broken off,—forming part of the edge of a cutting instrument. These were examined microscopically and their nature verified; they were covered with blood. In a box in the prisoner's room two razors were found. The blade of one of these was stained with blood from end to end—it had been partly wiped. The edge of this razor presented several notches, corresponding to the portions of steel found on the neck-bone of deceased. The handle of the razor was also partly unriveted, showing that it had been used with very great force. Suicide was not only thus disproved, but the act of murder was fixed upon the accused.

Marks of blood on clothing or furniture.—It is proper to notice all marks of blood on the clothes of the deceased or in the apartment, and to observe where the greatest quantity of blood has been effused; this is generally found on the spot where the deceased has died. The deceased may have bled in more places than one; if so, it is proper to notice whether there is any communication in blood between these different places. Blood on distant clothes or furniture will show whether the deceased has moved about, and whether he has struggled much after receiving the wound. Acts of locomotion by a wounded person who has died from loss of blood, or by a criminal whose hands and feet may be bloody, are generally indicated by tracks or marks of blood. The observation of these marks is of medical importance if made at the time that a dead body is found. They may be so situated as to show that the body has been moved or been interfered with after death, and thus throw a light upon the question whether the act has been one of homicide or suicide. In *Reg.* v. *Hatto* (Bucks Lent Ass., 1854), a mark of blood, as from the smear of a hand, was traced

along the passage of the house in which the body of the deceased was found. The mark was continued over the door-post into a back room, which was found locked and bolted on the inside. The crime was thus fixed upon the prisoner; for no one breaking into the house in front could have had access to this room. The evidence thus brought against him was derived from his feeling his way with a bloody hand in the darkness after the murder. He was not at the time aware that he was thus leaving impressions which would show that no one but himself could have perpetrated the crime. It is a fair subject of medico-legal inquiry on these occasions, whether there are any marks of blood about the apartment or the spot where a murder is alleged to have been perpetrated, which no one but the assassin could have produced.

In the case of Mr. Briggs (*Reg.* v. *Müller*, Central Crim. Court, October 1864), it was proved that the outside handle of the carriage-door in which the fatal assault was made was marked with blood, while there was no blood upon the hands of the deceased, which were examined soon after the occurrence. This was adverse to the theory that deceased had opened the door, and had fallen out, while it proved that a hand stained with fresh blood had been in contact with it.

In the case of Mrs. McPherson (the *Queen against Jessie McLachlan*, Glasgow Circ. Court, Sept. 1862), Dr. Macleod observed footprints in blood in the bed-room of deceased, who was found dead from wounds obviously homicidal. There were three imprints of a naked left foot, one of them particularly well marked. There was the impression of a small well-formed foot at rest. Before any suspicion was attached to any one, the medical witness expressed an opinion that they were made by a woman's foot with a high instep. At the time of this act of murder there were only three persons in the house—the prisoner, the deceased, and a man aged 87, James Fleming. Dr. Macleod observed, when he made an inspection of the body, that there was no blood on the feet of the deceased—further, he made a careful outline of her left foot, and found that it did not in any way correspond to the footprints on the floor of the room. The foot of deceased was larger in all dimensions, it was longer and broader, and had a large bunion. In his opinion the left foot of the deceased could not have produced these marks. He compared the foot of James Fleming with the footprints, and they were obviously quite different. He had a flat foot, in contradistinction to a high sole by which the marks had been produced. He was quite satisfied that the old man's foot could not have caused them. He also compared the feet of the prisoner with these marks, especially the left foot, and the marks in his judgment might have been produced by her foot. The accused made no objection to tread with her left foot in a thin layer of bullock's blood and then step on a plank of wood. When all the conditions of the floor were imitated, two impressions were obtained which corresponded with a marvellous degree of accuracy with the marks taken from the house. In the minutest detail of measurement and outline they tallied with the original. ('Report of Medical Evidence,' by Dr. Macleod, 1862, p. 13.) This was one among the numerous circumstances which tended to fix the act upon the prisoner.

Criminals sometimes show great anxiety to supply evidence, in order to avert suspicion from themselves. In *Gardner's* case (p. 491) it was remarked by the surgeon that there was no blood on the wainscot or part of the bed-furniture of a room where, had the woman Humbler perpetrated or participated in the act, it was supposed it would be found. On the following day, the fourth day after the murder, some blood was pointed out in this situation by the prisoner; it had the appearance of having been recently splashed or smeared. One patch was still wet! This had been obviously done to furnish that evidence against the woman by which the prisoner hoped to avert suspicion from himself. Fortunately the room had been well examined on the previous day by the surgeon

and a policeman, and they were able to depose that the marks of blood in the room had been caused subsequently to their examination. The evidence thus supplied was therefore against himself, and in favour of the woman whom he accused.

In reference to clothing, it is advisable, if it be possible, to have some clear proof that the clothes sent for examination were actually worn by the accused, or that they had belonged to the deceased and were really taken from the body. Serious mistakes are sometimes made, and opinions should therefore be expressed with caution. In the case of *Hatto* (Bucks Lent Assizes, 1854), the clothes said to have been worn by the prisoner on the night of the murder were sent to me for examination. On the shirt there were no marks of blood: on the trowsers and cap there were a few stains of blood: but it was admitted that, from the appearance of these, they might have been on the clothes five or six weeks, and therefore several weeks prior to the date of the murder. Owing to this want of certainty respecting date, these clothes were not produced in evidence; and it subsequently turned out by the confession of the prisoner, and the discovery of other articles of dress in places where he admitted he had concealed them, that the clothes which had been examined were not worn by him when he perpetrated the murder! In the case of *Munro* (Cumberland Spring Assizes, 1855), the clothes supposed to have been worn by the prisoner were also sent to me for examination. There was no blood on the trowsers, and it appeared, from the evidence given at the trial, that the prisoner had changed this article of dress before he was apprehended. In a case of suspected murder, we should examine for blood not only articles of dress produced by the police, but any others that might have been worn by the accused at the time of the occurrence. In the Road murder (*Reg.* v. *Constance Kent*, Wilts Summer Ass. 1865), the omission to inquire minutely in the first instance into all the articles of dress led to the defeat of justice. The prisoner, a girl only sixteen years of age, showed an amount of cunning, in the perpetration and concealment of this act of murder, rarely met with among old and experienced criminals. From the nature of the wounds on the body of the infant, her step-brother, it was not probable that the dress of the person inflicting them could have escaped being stained. It appears that she had *three* night-dresses, but only two were produced. When asked for an explanation, she said one had been lost at the wash a week after the murder. This was proved to be a falsehood by the laundress and her daughter. From other facts proved in the case, there was no doubt that the prisoner had secreted soon after the murder one of her night-dresses stained with blood; she then put out a clean one for the wash to avoid suspicion, but afterwards clandestinely took this back again to her bed-room. This gave some ground to her statement that the missing one of the three had been lost at the wash. Within twenty-four hours of the murder, a chemise wrapped in brown paper and stained with blood was found by a policeman in a fire-hole in the scullery; this was most probably the missing night-dress. She stated in her confession that she burnt the dress worn on the night of the murder five or six days afterwards. The three night-dresses should have been produced or accounted for at once; and had this been strictly carried out, a heavy load of suspicion would have been removed from several innocent persons, and a crime like this would not have remained concealed for five years.

It is proper to observe on these occasions whether the blood is deposited in large patches on clothing, or whether it is sprinkled, and also to make a note of the quantity. The sprinkling may have proceeded from a wounded artery or from a splashing of blood as a result of continued violence. We should likewise notice whether, if the wound is in the throat or chest, blood has flowed down in front of the clothes or person, or whether it has flowed so as to collect

in the armpits, or on each side of the neck or under the back; for these appearances will sometimes show whether the wound was inflicted when the person was standing, sitting, or lying down. If the throat is cut while a person is lying down, it is obvious that the blood will be found chiefly on either side of the neck, and not extending down the front of the body. Few suicides cut the throat while in a recumbent posture, and the course which the blood has taken may, therefore, sometimes serve to distinguish a homicidal from a suicidal wound. The position of the body when a wound was inflicted, is a frequent question on inquests and criminal trials. In the case of *Lord William Russell* (*Reg.* v. *Courvoisier*, C. C. C. 1840), the throat had evidently been cut while the deceased was lying in bed; the blood was effused on each side of the neck only. There was also found a wound on the thumb of the right hand of the deceased, which was probably inflicted at the time the hand was put up to defend the throat. The case of *Mrs. Gardner* (*Reg.* v. *Gardner*, C. C. C. Oct. 1862), already referred to as illustrating other important medico-legal points (see p. 491), bears a strong resemblance to that of Lord W. Russell, but the proofs of murderous interference with the deceased were still stronger. Her throat had been cut while she was in the recumbent position. Mr. Sequeira, who made the examination, found an impression made by sooty fingers on the inside of the left wrist, and a similar sooty impression on the left elbow, as if it had been forcibly grasped. On the inside of the right thigh there was the impression of the palm of a bloody hand of full size, pointing downwards. He noticed these marks before the prisoner, who was a chimney-sweep, had entered the room, and he also observed that there was no soot on the hands of the deceased, and no blood sufficient to produce such an impression of blood as that existing on the right thigh. The impression was also larger than the hand of the deceased.

In a case of fratricide referred to Dupuytren, the deceased had received a severe wound at the lower part of the neck, and another in the front of the chest, which had led to his death. As the blood had run down the front of the person from both of the wounds, and one of them was so deep that the deceased, unless supported, would probably have immediately fallen, M. Dupuytren inferred that two persons had been engaged in the murder, and that one held the deceased by the arms while the other struck him in front. This suspicion was corroborated by there being no marks of wounds upon the hands. The opinion thus expressed was singularly confirmed by the evidence adduced at the trial of the murderer. ('Ann. d'Hyg.' 1829, 1, 465.) If the deceased has been wounded with his clothes on, we should notice whether any part of his dress has or has not been cut or injured over the situation of the wound: whether the cut portions of dress are bloody, and whether the blood has been effused or applied on the *inside* or *outside*. When, together with a wound in the throat, we find the cravat and the shirt, or in a female the collar or bonnet or cap-ribbons cut through, this, all other circumstances being equal, is strongly presumptive of homicide. A person intending suicide, unless labouring under confirmed insanity, would not allow any mechanical obstacles of this kind to remain as an obstruction to the use of the weapon. In one case of homicidal wound of the throat, inflicted in the recumbent posture, the cravat of the deceased had been lifted up, and afterwards allowed to drop over the wound, in order to conceal it. The importance of examining the dress, and comparing it with the marks of violence on the body, has already been pointed out.

Inference from the quantity of blood.—When the blood-vessels of the neck have been divided to the vertebral column, and the amount of blood on the spot where the body is found is small, there is reason to infer that the act is homicidal, and that the wound has been produced soon after death from some other cause. The Road murder, referred to *supra* (*Reg.* v. *Constance Kent*),

furnishes an illustration of this kind. In reference to young children, the question of self-infliction cannot be raised to embarrass the case: nevertheless, from such a wound as that inflicted on the deceased, there should be evidence of spurting and copious loss of blood; but the quantity of blood on the spot where the body of the child was found was so small (about two tablespoonfuls) compared with the severe wounds on the neck, that the medical man properly drew the conclusion either that the wounds had been inflicted elsewhere, or that they had been produced on the body after active circulation had ceased. There was reason to believe that the child had been first suffocated, and the severe wound dividing the blood-vessels of the neck inflicted soon afterwards, although this is not in accordance with the prisoner's confession. A case somewhat similar, but involving the death of a lady of good social position, occurred in the United States a few years since. The following particulars have been communicated to me by Dr. Swinburne, of Albany, U.S. This lady was found dead in bed with her throat cut, and the bed-clothes smoothly arranged about her person. Although the soft parts of the neck, including the carotid arteries, the trachea, and œsophagus, were cut through to the spinal column, there was no appearance whatever of a jet or spurt of blood, or as if blood had been poured out from the divided vessels. There was no blood on the fore part of the neck above or below the cut, nor on the hands, with the exception of a small stain on the inside of the fingers of the right hand. The blood effused is said not to have exceeded a quart: this had evidently escaped from the wound in the neck, and had flowed down behind the body. Besides these marks, there was a spot of blood on the sheet in front of the body entirely removed from the wound and other spots on the bed-clothes. The blood continued to ooze freely from the wound for twenty-four hours after death, in spite of the efforts made to repress it. Was this a case of murder or suicide? Apart from all moral circumstances, the medical facts were such as to justify the inference that this wound was homicidal. The attitude of the body, as if laid out—the razor partly closed, found under the right arm, the hand not bloody; the absence of blood from the front of the person, showing that this deep and extensive wound, if suicidal, must have been inflicted while deceased was lying down; and, above all, the small quantity of blood (one quart) which had flowed from a wound involving all the great vessels of the neck to the vertebral column—were facts presumptive of homicidal interference. Had the throat been cut while the deceased was living, there would have been a great flow or spurt of blood, but as there was no evidence of this, Dr. Swinburne and others who investigated the case came to the conclusion that the woman had been first suffocated or strangled, and her throat cut while she was lying down.

Observations made in carrying out sentences of execution by decapitation show that on a division of the great blood-vessels of the neck during active life the flow of blood is copious and instantaneous. In the case of *Mrs. Gardner* (p. 491), the body was straight on the floor, as if laid out, and although the carotid artery had escaped division, there was a pool of blood on the floor on each side of the throat, and this had run down the back. A quantity of blood escaping from the thyroideal artery, had entered the trachea and caused death by suffocation.

When spots of blood are found upon articles of dress or furniture, their *form* and *direction* may occasionally serve to furnish an indication of the position of the person with respect to them when the wound was inflicted. Thus, if the form of a spot is oval and elongated, the presumption is that the person was placed obliquely with respect to the stained furniture during the hæmorrhage. ('Ann. d'Hyg.' 1840, 1, p. 397.) The force with which the blood has been thrown out will be in some measure indicated by the degree of obliquity

and length of the spot. This is in general wide and rounded at the upper part, but narrow and pointed below. The case of *Spicer* furnishes some suggestions on the importance of evidence occasionally derived from an examination of the form and direction taken by spots of blood. At the top of the stair, and at the height of four or five feet above its level, several spots of blood were observed upon a brick wall. (See illustration, p. 537.) These were rendered evident by the wall having been recently whitewashed. The spots took an oblique direction from above downwards, were of a pale red colour at the upper part, but dark red below, terminating in a point consisting of the fibrin and the greater part of the red colouring matter. Their form and regularity proved that they had proceeded from a small artery, and that the wounded individual could not have been very distant from the wall, while their shining lustre rendered it probable that they were of recent origin, and their well-defined termination in a firm coagulum showed that they had probably proceeded from a living blood-vessel. The deceased had died from fracture of the skull and vertebral column by a fall from the top-stair; one branch of the right temporal artery was found divided, and this wound could not have been produced by the fall. It was therefore evident that a murderous assault had been made upon the deceased at the top of the stair, and this had led to the spurting of the arterial blood on the brick. The height at which the spots existed, and their appearance, proved that the jet of blood had been from above downwards, thereby rendering it probable that deceased was standing up, or that her head was raised at the time the wound was inflicted. Further, as the brick with the spots was on the left hand in the descent, and the wounded artery was on the right side, it is probable that deceased was face to face with her assailant in the act of ascending the stairs, and that she was killed by being precipitated backwards to the bottom. The position in which the body was found in the cellar corroborated this view. ('Med. Gaz.' vol. 37, p. 612.)

In examining a dead body, attention should be paid to the state of the *mouth* and *throat*. Assailants who make their attack during sleep sometimes endeavour to close the mouth, or to compress the throat, so as to prevent an alarm being given. In the case of the *Duchess de Praslin*, there were the marks of finger-nails around the mouth. In another case, ecchymosed impressions, as if produced by a hand, were found upon the throat of the deceased. The *hands* of the dead person should always be examined; many cuts, excoriations, or incisions found upon them, especially if on the dorsal surface (back), will indicate that there has been a mortal struggle with the assailant. In the inspection, the examination of the *stomach* should not be omitted. The presence or absence of food, mucus, or blood, may furnish evidence of considerable importance in the elucidation of the case. Thus, in the stomach of the *Duchess de Praslin*, a quantity of bloody froth was discovered. This rendered it certain that she had lived sufficiently long to swallow a quantity of saliva mixed with blood, and that probably she had made some attempts to give an alarm. The fact that several days have elapsed since death will not prevent the discovery of food in the stomach, provided it has been taken within one or two hours before death: since the digestion of food does not appear to go on to any perceptible extent after death. I have thus discovered food in the stomach twenty-eight days after interment. This question connected with the digested or undigested state of the food found in the stomach, frequently arises on criminal trials.

The nature of the dried spots of *mud* on clothing may occasionally serve to connect an accused person with an act of murder. In the case of *The Queen* v. *Snipe and others* (York Winter Assizes, 1852), evidence was adduced to show that some spots of mud on the boots and clothes of the prisoner, when

examined microscopically, presented infusorial shells, and some rare aquatic vegetables, particles of soap, confervæ, and hairs from the seeds of groundsel. The mud of a ditch close to which the body of the deceased was found presented the same microscopic appearances as the mud from the prisoner's boots: and the witness who gave this scientific evidence deposed that in his opinion the mud-spots were derived from this ditch. He had examined the mud of all the other ditches in the locality, and found it to be different. Admitting the opinion to have been correct, this circumstance clearly connected the prisoner with the act; and it was borne out by the fact that he had been seen near the spot on the night of the murder. In a case which occurred in Nov. 1857, I found granules of wheat-starch mixed with the blood-stains on the gaiters of a man charged with murder. He had been just before the occurrence engaged in sowing seed-corn. So in *Reg.* v. *Steed* (Maidstone Summer Assizes, 1863), Dr. Pavy and I discovered on the soles of the boots belonging to the prisoner, portions of farinaceous matter adhering to the nails in addition to blood, hair and woollen fibres. It was proved in evidence that after the murder the prisoner had gone into a country baker and flour-dealer's shop, and trodden on the floor on which there was flour. This chemical fact tended to corroborate the evidence that the prisoner was the man who had been seen in the shop.

Marks of blood or other substances on the deceased.—All marks or stains of blood or dirt on a dead body require special observation. The impression of a hand, or of some of the fingers, may be found on the skin in a situation where it would have been improbable or impossible for the deceased to have produced it, even supposing that one or both of his hands were covered with blood. In one case of murder there was found the bloody impression of a left hand upon the back of the *left hand* of the deceased, in such a position that it was quite impossible the deceased himself could have made the mark! In all cases it should be noticed whether the *inside* or *outside* of the hand or whether one or both hands are marked with blood, and the size and position of the marks should be described. Stains of blood on the dress of a wounded person or dead body may often furnish important circumstantial evidence. If there are several stabs or cuts on the body involving the dress, it should be observed whether the edges of one or more of them are stained with blood, as if from the wiping of a weapon, and whether the stain is on the outside or inside of the article of dress. In simulated personal injuries, the stain of blood may be, through inadvertence, applied to the outside of the dress—a fact which might, in some instances, lead to the detection of the imposture. (See case by Dr. Bayard, 'Ann. d'Hyg.' 1847, 2, 219.) In judging from marks of blood in the *apartment*, we must take care that we are not unconsciously misled by the accidental diffusion of this liquid by persons going in and out or touching the body. The following case, which occurred in France, will show the necessity of extreme caution. A young man was found dead in his bedchamber, with three wounds on the front of his neck. The physician who was first called to see the deceased had, unknowingly, stamped in the blood with which the floor was covered, and had then walked into an adjoining room, passing and repassing several times; he had thus left a number of bloody foot-prints on the floor. No notice was taken of this at the time; but on the following day, when the examination was resumed, the circumstance of the foot-prints was particularly attended to, and excited a suspicion that the young man had been murdered. The suspected person was arrested, and would have undergone a trial on the charge of murder, had not M. Marc been called in to examine all the particulars of the case. A similar circumstance occurred in the case of *Eliza Grimwood*, who was murdered at Lambeth in June 1838.

Marks of blood or wounds on the assailant.—It is a very common idea that

no person can commit a murder in which blood is effused without having his person and clothes more or less covered with blood. Nothing can be more erroneous. On several occasions I have been required to examine articles of clothing which had been worn by persons subsequently convicted of murder by wounding, and either no blood has been found on any part of the dress, or only small spots wholly out of proportion to the quantity of blood which must have flowed from the deceased. (*Reg.* v. *Harrington*, Chelmsford Assizes, 1852. *Reg.* v. *Flack*, Ipswich Assizes, 1853. *Reg.* v. *Cass*, Carlisle Assizes, 1860. *Reg.* v. *Rowlands*, Beaumaris Assizes, 1861. *Reg.* v. *Edmonds*, Swansea Assizes, 1862.) In the case of *Gardner* (C. C. C. 1862), in which there had been a large effusion of blood from a severe wound in the throat, no blood-stains were found on the clothing of the man who was convicted of the murder. It is obvious that the throat of a person while standing, sitting, or kneeling, may be cut by a murderer from behind, and thus in appearance simulate suicide. Under these circumstances the clothes of the assassin would escape being stained with blood. The flowing or spurting of blood upon his clothes will depend upon his position in relation to the deceased at the time of inflicting the wound, and this must always be a matter of pure speculation. In entire violation of this simple principle, the fact of a prisoner's clothes not being marked with blood, has been on more than one occasion urged as a proof of his innocence. (*Reg.* v. *Dalmas*, C. C. C., June 1844.) In this case the counsel for the prisoner wished to impress the jury, in what is commonly denominated a 'powerful' speech (in which medical facts and opinions are usually ignored), that no person could cut the throat of another without having his clothes covered with blood; and as it was not proved that there was any blood on the clothes, the prisoner could not have been guilty of the crime. The facts were simply that the throat of the woman was cut while she was walking across Battersea bridge, the prisoner having inflicted the wound from behind! In the case of *Lord W. Russell*, pp. 485, 506, the act of murder was committed by Courvoisier while in a state of nudity. In *Reg.* v. *Müller* (C. C. C., October 1864), this fallacious species of defence was carried to a still greater length. Although the clothes of the prisoner were not produced, and the evidence showed that he had had time to change them, the counsel for the defence, in addressing the jury, said, 'Blood spurted out from Mr. Briggs (the deceased), and there is no doubt his assailant, whoever he was, must have been covered with blood, or have been considerably stained with it.' It should be observed, however, that the wounds were of a contused character, from which much blood was not likely to have flowed at the time of their infliction. The clothes worn by the assailant need not, therefore, from this state of facts, have been 'covered with blood,' or 'considerably stained.' No artery was cut through, and there was no evidence of spurting. Setting aside these erroneous assumptions, the evidence tended to show that had blood fallen upon his clothes, the prisoner had had ample time to dispose of them, and thus prevent a chemical examination of them. It is a new feature to have their non-production under such circumstances dealt with as a proof of innocence. In a case tried at Liverpool (*Reg.* v. *Smith*, Liverpool Aut. Ass. 1867), too great a reliance upon the absence of blood-stains on the dress of the accused, as adverse to the theory of guilt, appears to have led to a failure of justice. The deceased was found dead with his throat cut. The wounds in the throat were of such a nature that they could not have been inflicted by deceased himself, and were consistent with the view that they might have been made by another person from behind. The accused was traced to the spot, and a cap belonging to him, and saturated with blood, was found under the dying man. In his address to the jury the learned judge is reported to have said: 'There were very slight, if any, traces of blood upon his clothes, and it appeared to him impossible that

the person who committed this deed should not have been deluged with blood from the wound, &c.' The medical evidence was to the effect that there were some stains of blood on the clothes, which were damp. They had been washed. The jury acquitted the prisoner. The fact of finding the bloody cap admitted of no explanation consistent with innocence: but the fact that the clothes were not 'deluged with blood' was taken as a strong presumption against guilt, whereas, medically speaking, it merely indicated that the throat of deceased might have been cut from behind! The position in which the dead body was found, with the face downwards, rendered this highly probable. In another case, tried before the same learned judge at the Central Criminal Court, July 1871 (*Reg.* v. *Pook*), commonly known as the Eltham murder case, a young woman was found dead, with severe injury about her head inflicted with a plasterer's hammer. One of the wounds divided the temporal artery. The prisoner's clothes were examined by Dr. Letheby, and he found upon them numerous small spots of blood, apparently recent. The learned judge, in addressing the jury said, 'Was it likely that the person who inflicted all that violence, dividing arteries as it did in some places, could have done it without considerable marks of blood being afterwards found upon his clothes?' This question, if addressed to a medical witness who had had experience in examining such cases, would have been answered in a very different manner from that suggested by the learned judge. The spots found by Dr. Letheby were such as might have arisen from the use of a plasterer's hammer in inflicting these wounds. The effect of spurting on the clothes by the divided temporal artery would have depended on the position of the assailant at the time. By a bruising instrument of this kind 'considerable marks of blood' were not likely to have been produced. In a recent trial in Ireland (1872) the non-discovery of blood on the clothes of the accused was advanced as a strong proof that he could not have committed the act of murder with which he was charged. There is no doubt that policemen are often misled in searching for criminals, by relying upon blood on clothing as a necessary accompaniment of an act of murder. This also leads them to magnify stains of red paint, iron rust and fruit-stains, on the dress of an accused person, into marks of blood.

The presence of spots of blood on articles of clothing, knives, &c., taken from the persons of those who are accused of murder, may be quite consistent with innocence. Small spots or stains have often an undue importance attached to them. I have known minute spots of blood on the shirt of a man tried for murder by wounding, regarded as furnishing proof of criminality, until it was explained that they were probably derived from flea-bites, and that some were on one side and some on the other, showing that the shirt had been worn on the two sides. The coarse clothing worn by labourers may acquire blood-spots from a variety of accidental circumstances which the accused may not always be able to explain. When an attempt has been made to wash out the stains, or the accused admits that they are there, and shows great anxiety to give some explanation of their presence, as that he has assisted in killing a pig, rabbits, or rats, or that he was carrying game about him, there may be some ground for suspicion. A medical practitioner should always make due allowance for the accidental presence of blood. In *Reg.* v. *Cass* (Carlisle Summer Assizes, 1860), among twelve different articles sent to me for examination for blood, was a sovereign, which it was supposed had been taken from a purse belonging to the deceased at the time of the murder and had been touched by a bloody hand. Although the reddish-coloured spot, which was in the letters near the rim, presented the appearance of dried blood, yet a chemical examination showed that it was not blood. A few days after, I examined a number of sovereigns received from a public bank. Some of these presented spots

similar to that on the sovereign above mentioned, and one among them had a spot of dried blood upon it! A knife, coin, or purse, handled with a cut finger, might, if found in the possession of an accused person, be thus inadvertently set down as a proof of guilt.

If no blood is found on the clothing of a person charged with murder, any wounds or marks of violence upon him should be specially examined. These may have been produced in a struggle with the deceased, and the accused may not be able to give any consistent account of the time or mode of their production. A case has been related (p. 464) in which the identity of an assailant was in some manner established by the form of an ecchymosis on his face. So a wound may be found on the accused which he may pretend to account for by some accident, in order to evade suspicion. His statement may, however, be wholly irreconcilable with the appearances of the injury. The kind of weapon used, and the period at which it was inflicted, may sometimes be inferred from a simple examination, and prove that the prisoner's story is false. A case of this kind was tried in the West of England a few years since, in which an assailant was identified by the peculiarity of a wound on the knee. He had broken into a house at night with some others, and discharged his gun at the prosecutrix, while he was in the act of kneeling or stooping. The gun burst, and the recoil of the breech produced a mixed laceration and contused wound on the knee of the assailant. When the prisoner was called upon to account for this wound, he referred it to an accidental blow from a mandril some time before. The appearance of the injury was, however, inconsistent both with the time of its alleged accidental infliction, and with the instrument said to have produced it; while, on the other hand, it was proved to corespond to such an injury as the broken breech of the gun would have produced at the date of the burglary. This led to the identification of the prisoner and his subsequent conviction.

Mr. Smith, a gentleman who formerly attended my lectures, communicated to me a singular case in which identity was established by the production in evidence of a portion of a finger belonging to the assailant. In 1834, two men were charged with having assaulted with intent to rob the prosecutor, a surgeon. It appears that the prosecutor, while walking late at night along a lonely road in the country, overtook three men who were strangers to him. One knocked him down by a severe blow on the face, and held him, while another put his hand upon his mouth to prevent him giving alarm. The prisoner contrived to get his finger into the prosecutor's mouth, and during the struggle the latter bit off the end completely between the nail and the first joint. The men then ran away. The piece of finger was given to a constable, and in the course of about eight hours he found one of the prisoners with his hand bandaged. On examining the hand, it was ascertained that the tip of one finger was missing. The prisoner accounted for this by saying that he accidentally cut it off. This statement was found to be false, and he made several other inconsistent statements. On comparing the piece of finger with the injured finger of the prisoner's hand, they were found closely to correspond. The portion of finger was preserved in alcohol for the trial, and upon this clear evidence of identity he and his companion were convicted. These cases may be taken as types of many others of a similar description.

Cerebral matter.—Under severe injuries to the head, a portion of the brain may escape and be deposited with blood on articles of clothing or furniture. Orfila first directed the attention of medical jurists to this subject, and suggested the application of certain chemical tests to the dried spots of brain-matter ('Ann. d'Hyg.' 1850, 2, 143). He found that strong sulphuric acid applied to dry cerebral substance dissolved it and gave to it a violet colour. He also observed that hydrochloric acid operated in a somewhat similar manner, but

much more slowly. Orfila did not find that albumen or albuminous tissues were similarly changed by the acid. M. Lassaigne, who has more recently examined this question, advises the use of sulphuric acid only in its highest state of concentration. ('Ann. d'Hyg.' 1855, 1, 442.) He found that a drop of this acid placed on a dry stain of cerebral matter produced almost immediately a yellowish colour. In twelve seconds it acquired an orange tint, in twenty-five seconds a vermilion red, and in two minutes a violet colour which gradually disappeared in about an hour, as a result of the absorption of moisture from the air. He thinks the colouring effect is owing to the action of the acid on the cerebral cholesterine and not on the cerebrine. His observations apply equally to the action of the acid on the substance of the spinal marrow.

M. Robin has employed the microscope. With this instrument, by maceration of the substance in water or in a solution of the sulphate of soda, he has been enabled to discover in these dried spots the long slender cerebral tubes. It required for this purpose a power of from 500 to 600 diameters. If an examination of stains of supposed cerebral matter were required in practice, the application of the microscope by a competent observer, would be preferable to the chemical methods above described. Sulphuric acid produces a variety of colours with organic substances, and a chemist might be easily deceived. In a case of murder which occurred some years since, in which the deceased had sustained severe injuries to the head, an expert professed to have discovered with the stains of blood on cloth a quantity of brain substance; but on the post-mortem examination of the body, it was found, that although there was fracture of the skull, the cavity had not been opened and no brain had escaped! This shows that no reliance can at present be placed on tests for this substance.

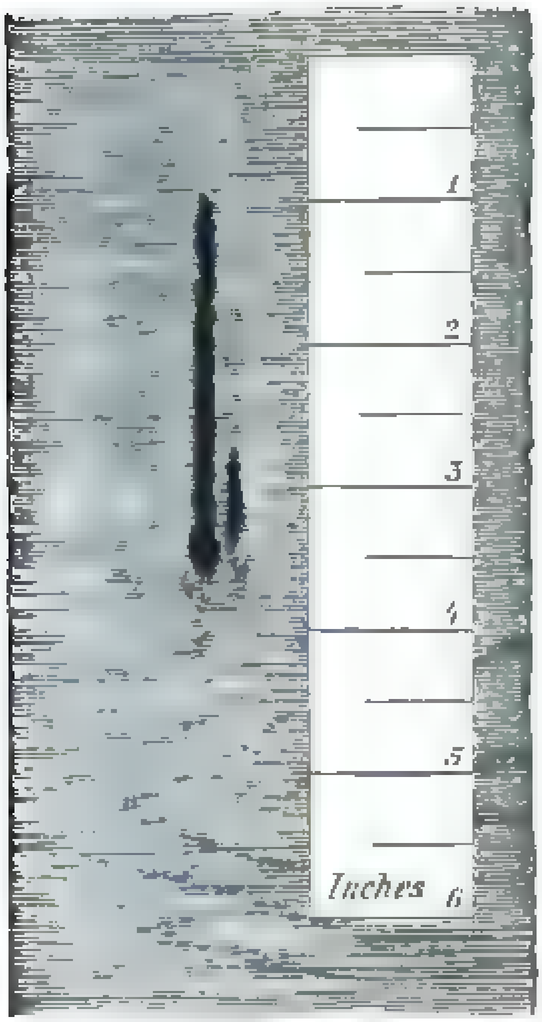
CHAPTER 38.

EXAMINATION OF BLOOD-STAINS—CHEMICAL, OPTICAL, AND MICROSCOPICAL EVIDENCE—STAINS OF BLOOD ON LINEN AND OTHER STUFFS—AGE OR DATE OF THE STAINS—INSOLUBLE STAINS RESEMBLING BLOOD—STAINS OF FRUITS, FLOWERS, ROOTS, AND EXTRACTS—STAINS OF BLOOD ON WEAPONS—STAINS FROM IRON-RUST—ARTERIAL AND VENOUS BLOOD—THE GUAIACUM PROCESS—SPECTRAL ANALYSIS—VARIETIES OF BLOOD—BLOOD OF MAN AND ANIMALS—BLOOD CRYSTALS.

Examination of Blood-stains.—It may appear at first sight an easy matter to say whether certain suspected spots or stains on articles of clothing, furniture, or weapons are or are not owing to blood; but, in practice, great difficulty is often experienced in answering the question. If the stains are large and recent, most persons may be competent to form an opinion; but the physical characters of blood are soon changed, even when the stuff is white and otherwise favourable for an examination. If the stains, whether recent or of old standing, are upon dark-dyed woollen stuffs, as blue, black, or brown cloth, or if they appear in the form of small or detached spots, or in thin films on dark clothing or rusty weapons, no one but a competent medical man should be allowed to give an opinion. Before proceeding to an analysis, it may be occasionally necessary to show the exact size and position of blood-stains when found on articles of furniture. For this purpose photography may be employed. In the case of *Raynor*, *Reg.* v. *Watson and wife* (Notts Lent Assizes, 1867), the position of certain splashes of blood on the flap of a kitchen-table was of some importance in the case. The annexed engraving (fig. 108) is from a photograph, taken to a scale of inches, showing the relative position and length of two

streaks of blood. (See case, p. 513.) A photograph thus made will give a better idea of quantity and position than any verbal description. There are three methods of examining blood stains: 1, by chemical processes; 2, by the microscope; and 3, by an optical process—spectrum analysis. In some cases it is necessary to combine these processes in order to arrive at a conclusive result.

Fig. 108.



Stains of blood on the flap of a table. Case of *Raynor*, *Reg.* v. *Watson and wife* (Notts Lent Assizes, 1867).

Chemical Analysis.—There is no direct chemical process by which blood can be identified, but we presumptively establish its nature by determining the presence and properties of the red colouring matter or *hæmatin.* The chemical properties of the red colouring matter of blood are as follows:—1. It readily combines with cold *distilled water*, forming, if recent, a bright red solution. 2. The red colour of this solution is not changed to a crimson, blue or green tint by a few drops of a weak solution of *ammonia.* If the ammonia is concentrated, or added in large quantity, the red liquid will acquire a brownish tint. 3. The red solution when heated to about 170° is coagulated—the colour is entirely destroyed, and a muddy brown flocculent precipitate is formed, the quantity of which will depend on the quantity of colouring matter and albumen present. The red colouring matter of blood is always more or less mixed with albumen, and it is this principle which gives to a dried blood-stain on linen or cloth a well-marked stiffness. Stains from cochineal and the red colours of wine, flowers, and fruit, do not cause any stiffening of the fibre of the stained stuff, nor any appearance under the microscope at all resembling a dried coagulum of blood. 4. A solution of the red colouring matter of blood in water produces with tincture of *guaiacum* only, a reddish-white precipitate of the resin. On adding to this an ethereal solution of *peroxide of hydrogen*, a beautiful blue colour is more or less rapidly brought out. If a sufficient quantity of alcohol or ether is added, the precipitate will be dissolved and a deep sapphire blue solution will result. Cochineal and other red colouring matters when thus treated give a reddish colour to the resin of the tincture of guaiacum, but undergo no change on the addition of peroxide of hydrogen. They are thus well marked and distinguished from blood. Whether the blood is new or old, whether concentrated or exceedingly diluted, the test produces the blue coloration. It produces the change better in a diluted than in a concentrated state. A drop of blood diffused through six ounces of water may be thus detected in one or two drachms of the mixture. Such are the chemical properties of blood, whether taken from the human body or from that of any warm red-blooded animal (mammalia).

Blood-stains on linen or other stuffs. Their age or date.—Supposing the stuff to be white or nearly colourless, the spot of blood if *recent*, is of a red colour; but sooner or later it becomes of a reddish-brown, or of a deep red-brown colour. The change of colour to a reddish-brown I have found to take place in warm weather in less than twenty-four hours. After a period

of five or six days, it is scarcely possible to determine, from the appearance, the *date* of a stain even conjecturally. In a large stain of blood on linen, no change took place during a period of fifteen years:—it had a reddish-brown colour at the end of six weeks, which it retained for the long period mentioned. Indeed, it is extremely difficult in any case, after the lapse of a week, to give an opinion as to the actual date of a stain. Chemistry does not aid the examiner. The stain may not be so readily dissolved by water, but no chemical test applied to the solution can enable a chemist to fix the date. Blood of one week's, and blood of six weeks' date, will present the same chemical properties. This question arose in the Eltham murder case (*Reg.* v. *Pook*, C. C. C. July, 1871). Dr. Letheby, who examined the prisoner's clothing, very properly declined to assign a date to the small stains which he had found upon it. The new method of spectrum analysis as applied to blood furnishes no precise information as to date. It allows us to make a distinction between fresh blood and that which has undergone chemical changes by deoxidation or otherwise, but not to fix a date. If a recent blood-stain has been exposed to smoke, or has been dried in an impure atmosphere containing sulphurous acid or sulphuretted hydrogen, its chemical and optical properties are changed as well as its physical appearance. It will look like a stain produced some weeks or months previously. Heat also affects the appearance of a blood-stain. Blood dried in a pure atmosphere and kept from air may retain its chemical character of freshness for a long time.

Dr. Pfaff, of Plauen, has performed numerous experiments on fresh and old blood-stains, with a view of determining their age or the date at which they were produced. (Casper's 'Vierteljahrsschrift,' 1862, 1, 266.) He considers that the rapidity with which the red colouring matter dissolves in water and other liquids, may constitute a safe basis for a medical opinion. It has been long known that the fresher the blood the more easily was the red colour imparted to water. It has also been pointed out that in fresh stains the colour is crimson-red, while in old stains it is brown or red-brown. The novelty of Dr. Pfaff's suggestion consists simply in fixing the age of the stain on linen and other stuffs by the time required for the commencement and completion of the solution of the red colouring matter. The solvent employed by him is a solution of arsenious acid in distilled water, in the proportion of one grain to two drachms of water. I have found this to be a good solvent for the red colouring matter. In operating on stains on linen and other stuffs, the rapidity of solution must however depend on so many contingencies irrespective of age, *e.g.* the quantity of the blood, the nature of the stuff, its thickness, and its permeability to liquid, that no definite rules can be safely laid down for determining the precise date.

Upon coloured stuffs, or dirty clothes, it is of course impossible to trace any physical changes in stains of blood—on red-dyed stuffs the stain appears simply darker from the first, but in all cases the fibre of the stuff is more or less stiffened, as a result of the drying of the albumen associated with the red colouring matter. In examining an article of clothing, attention should be paid to the side of the stuff which has first received the stain: sometimes both sides are stained. The evidence derived from an observation of this kind may be occasionally of importance.

Of the various red colouring matters extracted from vegetable and animal substances, there are none which, to the experienced eye, present the peculiar crimson-red tint of dry blood, especially when the substance is examined in a good light by a low power of the microscope. When solutions of these red colouring matters are treated with ammonia, some—such as cochineal, logwood, and the colours of roots and woods—acquire a deep crimson tint, while others, such as the colouring matter of the rose and the red colours of flowers

and fruits, are changed to a blue or green. These red colours are not destroyed by a boiling temperature, and even when mixed with albumen this principle is coagulated, but the red colouring matter remains unchanged. In the case of blood, the effect of heat is to destroy the colour entirely. Another distinction has been already pointed out (p. 527). Guaiacum tincture and peroxide of hydrogen produce no change of colour in these red colouring matters, while the red colour of blood is changed to blue. So far as it is at present known there is no red colouring matter, mineral, animal, or vegetable, which resembles blood in this respect.

Suspected stains on clothing.—The suspected stain, if in a dry state, should be first examined in a strong light, with a low power of the microscope. If caused by blood, it will not be a mere colouring of the fibres, but it will have a shining glossy appearance, and each fibre will be observed to be invested with a portion of dried coagulum or clot. In other cases, minute coagula or clots presenting the appearanee of dried jelly, will be seen in the meshes of the stained article of clothing. In certain lights the clots may appear of a dark red colour, but by changing the light, bright translucent portions of a peculiar crimson tint will come into view. The crimson colour of a blood-stain is unlike that of any other red colouring matter, and when the stained portion presents the character of a dry coagulum, the stain cannot be easily mistaken by a practised eye for that caused by any other red colour. In fact, the microscope puts the observer of a small stain in the same position as a non-professional person, who unhesitatingly forms his judgment from a large quantity of dried blood. Portions of kino over a dress may present occasionally the appearance of coagulated blood; but kino differs in colour and in chemical properties from blood. The microscopical observation of a suspected stain on linen, cotton, or woollen, however small, is generally sufficient to enable an expert to form an opinion either in the affirmative or negative. When the stain is on black or dark-coloured cloth, no colour will be visible. If owing to blood, the fibre will, however, be stiffened, and when viewed by reflected light it may appear glossy from the drying of the albumen or serum. The suspected spot should be wetted with distilled water, and when the cloth is thoroughly softened two or three layers of white blotting paper may be pressed upon it. If blood is present reddish coloured stains will be produced, sometimes extending through three or four folds of paper. Any one of these presenting colour may be tested by adding tincture of guaiacum followed by peroxide of hydrogen, and subsequently alcohol. The blue coloration produced by blood will then be apparent. If no red colour is thus obtained on applying the filtering paper to wetted cloth, no blood will be found. In a case of murder which was the subject of a trial at the Swansea Lent Assizes, 1868 (*Reg.* v. *Morgan*), it was proved that the deceased had been shot in a lonely hut on the hills. His only companion at the time was his dog. Some spots of blood fell on the hair of the dog. A portion of the hair was cut off and sent to me for examination. Small portions of fresh coagula were found in the hair. The hair was wetted and pressed strongly on white blotting-paper; tincture of guaiacum and peroxide of hydrogen applied to the red stains on paper gave at once the usual reactions of blood. The result was confirmed by other experiments. This method of testing by transference of the colouring matter from a dark to a white surface was first suggested by Dr. John Day, of Geelong, who has given so much attention to this subject. In all cases in which a doubt may exist, chemical and other processes should be resorted to for confirmatory evidence.

If the stain is of sufficient size, a slip of the article of dress, whether cloth or linen, should be suspended in distilled water contained in a small test-tube.

If the stain is owing to blood in a soluble form, a red or red-brown liquid will be seen to fall to the bottom of the tube. When a sufficient quantity has been thus collected, the clear water may be drawn off by a pipette, and the coloured liquid tested by ammonia, by heat, and by guaiacum, as already described (p. 529). Old stains are very slowly dissolved by water, and those which have been exposed to a heat of 170° or upwards, or to the influence of certain gases, are rendered more or less insoluble in water. Oil or grease in the stained article will also interfere with the solubility of the red colouring matter of blood. If the quantity of blood is small, the substance may be cut up and macerated in a porcelain capsule, with just enough water to keep it well moistened. After an hour the stained substance may be pressed, and a red-coloured liquid, in a state for testing, will be thus obtained. It may be objected that red stains resembling blood are occasionally found on linen and other stuffs, and may give rise to error. All such stains are either entirely insoluble in water or they are soluble and give red-coloured liquids. If the former, they cannot be easily mistaken for blood-stains: if the latter, no mistake can arise provided the red liquid so obtained is submitted to the chemical tests above described. Blood-stains rendered insoluble in water by heat or some other cause must be tested by another method.

The effect of *heat* in rendering the red colouring matter of blood insoluble, has been already described as a test for its presence (p. 527). In the case of a dead body found burnt, with stains resembling those of blood upon the clothing or furniture, due allowance must be made for a change of this kind. The insolubility of the matter forming the stain merely affects the chemical tests, namely, the application of heat and ammonia. That the substance is blood may be proved not only by the guaiacum process, but by the spectrum in the microscope. An insoluble coagulum of blood may be dissolved in ammonia by the aid of heat, and thus examined.

The changes produced by heat on blood became a subject of inquiry in the case of Raynor (*Reg.* v. *Watson and wife*, Notts Lent Assizes, 1857). (See p. 513.) Stains suspected to be those of blood were found on various articles of clothing belonging to the female prisoner. The woman had been making black-puddings with pig's blood a few days before the murder, and it was alleged in defence that the stains found on her dress, were produced with pig's blood while so occupied. The blood marks on the dress as well as the streak on the flap of the table (see fig. 107, p. 527) had the appearance of coagulated blood as effused from a living body. They formed a reddish-coloured solution in water like recent blood, and there was no more salt in them than would be contained in a like quantity of blood. Part of the dress was, for the sake of experiment, sprinkled with some of the black-pudding mixture, with the result that when dry, the stains were different in colour as well as in chemical and other properties. This mixture is made by heating blood and adding to it a quantity of salt. The stains thus made with the mixture were of a brown colour, insoluble in water, and contained much salt. It was clear from these results that the stains on the woman's dress could not have been caused by the black-pudding compound. On the other hand, it was admitted that pig's blood could not be distinguished from human blood either chemically or microscopically, and it was suggested that all the blood-marks would be accounted for and explained by the pig's blood being used or accidentally spilled before it was heated and mixed with salt.

Red stains resembling blood.—There are certain red stains bearing a resemblance to blood, which are insoluble in water. These may be identified by their special characters. Among them are:—1. *Red dyes*, such as madder, which when fixed by a mordant, is quite insoluble in water. 2. *Iron-moulds.* These are of a reddish-brown colour, sometimes of a bright or orange-red—they are

quite insoluble in water, but are easily dissolved by diluted hydrochloric acid, and on adding ferrocyanide of potassium to the hydrochloric solution, the presence of iron will be at once apparent. Care should be taken that the acid used for this purpose contains no iron. A more satisfactory method of testing is to apply to the spot glacial acetic acid, followed in a few minutes by a solution of tannic acid. A blueish purple stain of ink is produced, thus indicating that the spot is owing to oxide of iron. Tannic acid alone has no action on iron-moulds. Iron-moulds are generally distinguished by their brown colour, and by the absence of all stiffening of the fibre, on the stained spot. Notwithstanding these well-marked distinctions, mistakes are sometimes made, as in the following case. Some years since a man was found drowned in the Seine at Paris, under suspicious circumstances. The body had evidently lain a long time in the water. On examining the shirt of the deceased, a number of red-brown stains were observed on the collar and body—resulting, as it was supposed from spots of blood, which had become changed by time. On a chemical examination, however, they were found to be iron-moulds, produced by the rusting of a steel chain which the deceased had worn round his neck! 3. *Red paint.* Stains made with red paint containing peroxide of iron, have been mistaken for blood. They may be easily known by digesting them in diluted hydrochloric acid, and applying to the solution the tests for iron. Like those produced by iron-moulds, they are insoluble in water, and therefore cannot be confounded with ordinary blood-stains. The same may be said of spots of the ammonio-nitrate of silver changed by light, which I have known to be mistaken for old stains of blood. The stuff on which the spots of blood are found may be itself stained with a red dye or colour, or it may be dyed with iron: in this case it will be necessary to test by the same process a piece of the coloured or stained portion, in order to furnish negative evidence that the suspected stains are due to blood. In *Spicer's* case (*ante*, p. 521), an apron which the prisoner wore was found with stains of blood upon it; but the greater part was covered with dark red stains, which turned out to be owing to a logwood-dye that the prisoner had used in his business. ('Med Gas.' vol. 37, p. 613.)

Among soluble stains resembling those of blood are the spots produced by the juices of the *mulberry*, *currant*, *gooseberry*, and other *red fruits.* They are commonly recognized chemically by dropping on them a weak solution of ammonia, when the spot is turned either of a blueish, olive-green, or green colour. The red of cochineal is changed to a crimson on the addition of weak ammonia or potash. A spot of blood thus treated undergoes no change from a weak alkali. Acids turn them of a bright red colour. If a piece of the stained stuff is suspended in water, the coloured liquid, if any be obtained, is easily known from blood, by its acquiring a green or crimson tint on the addition of ammonia, and by the red colour not being *coagulated* or destroyed when the liquid is boiled. Independently of the fruits mentioned, there are vegetable juices that will produce stains of a red or red-brown colour, which might be mistaken for blood. In one instance the red petals of the poppy gave rise to an error only removed by a proper examination. (Bayard, 'Man. Prat. de Méd. Lég.' 217.) In some red stuffs the dye is often so bad that water will dissolve out of them a portion of the colour; but in this case the action of ammonia and heat will serve readily to distinguish the stains from blood. The soluble red or brown stains given by *Logwood*, *Brazil-wood*, or *Madder-root*, are changed to a *crimson* colour by ammonia. They generally contain tannic acid, and acquire a dark olive-green colour when touched with a persalt of iron. It may be remarked of these stains, whether they are soluble or insoluble in water, that, although to the naked eye they may bear a slight resemblance

to the red colour of blood, they are wholly different when examined microscopically. The distinction of tint is well marked, and there is an absence of any appearance of coagulum. When carefully examined, it is not probable that they can ever be mistaken for blood.

Removal of blood-stains. Examination of washed stains.—An attempt may have been made to wash out blood-stains, so that the colour may be more or less changed, and no chemical evidence obtainable. There is a common notion that certain chemical agents will remove or destroy these stains; but this is not the case: the colour may be altered, but when dried on the stuff it is not easily discharged or bleached. Chlorine, a most powerful decolorizing agent, turns the colouring matter of blood of a green-brown colour. Hypochlorous acid has a similar effect. This acid has been recommended as useful by its bleaching properties for distinguishing the stain of blood from all other stains, excepting those produced by iron-rust. Orfila has, however, shown that it is not fitted for such a purpose, and that there are no better methods of testing for iron than those above described. ('Ann. d'Hyg.' 1845, 2, 112.) I have found that nothing removes a blood-stain, whether wet or dry, so effectually as simple maceration in *cold* water, although, when the stain is old, the process is slow. *Washed stains* may now be readily detected by means of guaiacum, provided any red tint remains and they are on a colourless article of clothing. A drop of the tincture is poured on the stuff, and if there is no change of colour, peroxide of hydrogen is added. The blue colour appears immediately and becomes more intense by the evaporation of the ether, or on the addition of alcohol to dissolve the white resin. In *Reg.* v. *Baker*, a case involving a charge of murder and the mutilation of a little girl (Hants Autumn Assizes, 1867), the trousers of the prisoner sent for examination had been stained with blood in front. An attempt had been made to remove these stains by soaking them in water. This had carried the red colouring matter into the calico lining, and had given to some patches a strong and to others a pale reddish tint. The direct application of the guaiacum and peroxide indicated blood over a square foot of the calico lining, and beyond this, these liquids produced no change. The degree of the diffusion of the blood, as it had been washed from the front of the trousers into the lining, was thus clearly defined.

On an important trial for murder at the Shrewsbury Lent Assizes, 184 (*Reg.* v. *Misters*), this question as to the power of certain chemical reagents t remove stains of blood, was raised. Alum was traced to the possession o the prisoner: it was found dissolved in a vessel in his bedroom, and it wa supposed that he had removed the blood-stains from his shirt by the use o this salt. Two medical witnesses deposed that they had made experiment and had found that alum would take the stains of blood out of linen: according to one, sooner than soap and water. The results of my experiments d not correspond with these. I have not found that alum removes stains of bloo so readily as common water; and when alum is added to a solution of hæmatine in water, so far from the colour being discharged, it is slowly converte to a deep greenish-brown liquid. In one experiment a slip of linen, havin upon it a stain of dried blood of old standing, was left in a solution of alu for twenty-four hours, but not a particle of the red colouring matter had bee extracted, although it was changed in colour. The prisoner's guilt did not re on this point alone—that was made sufficiently evident from other circumstances; but there have been few cases tried in England where the facts connected with the analysis of blood-stains were so closely examined, or of such great importance as this. In a case to be presently related, I was consulte on the question whether the alkali contained in yellow soap would alter or remove blood-stains. The effect of this substance, as well as of potash, soda and their carbonates, is to change the red colour of blood to a deep greenish-brown

like many other reagents, but they do not exert on it any discharging or bleaching power. Combined with friction, fresh blood-stains may of course be easily effaced by any *cold* alkaline or soapy liquid.

Detection of blood on weapons.—When recent, and on a polished instrument, stains of blood are easily recognized; but when of old standing, or on a rusty piece of metal, it is a matter of some difficulty to distinguish them from the stains produced by rust or other causes. If the stain is large, a portion may be easily scraped off on drying. This may be placed in a watch-glass with some distilled water, the solution filtered to separate any oxide of iron, and then tested. If the water by simple maceration does not acquire a red or red-brown colour, the stain is *not* due to blood. If it acquires a red colour, the solution may be tested by the methods above described (p. 527). Sometimes the stain appears on a dagger or knife, either in the form of a thin yellowish or reddish film, or in streaks, and is so superficial that it cannot be mechanically detached. We should then pour a thin stratum of water on a piece of plate-glass, and lay the stained part of the weapon upon the surface. The water slowly dissolves the colouring matter of blood, and the coloured liquid may be examined by the chemical processes above recommended. If the weapon has been exposed to heat, this mode of testing will fail.

There is often a remarkable resemblance to the stains of blood on metal, produced by the *oxide or certain vegetable salts of iron.* If the juice or pulp of lemon or orange is spread upon a steel blade, and is exposed to the air for a few days, the resemblance to blood produced by the formation of *citrate of iron* is occasionally so strong that I have known well-informed surgeons to be completely deceived: they have pronounced the spurious stain to be blood, while the real blood-stain on a similar weapon was pronounced to be artificial! The difficulty of distinguishing such stains by the eye is well illustrated by the following case which occurred in Paris. A man was accused of having murdered his uncle, to whose property he was heir. A knife was found in his possession, having upon it dark-coloured stains, pronounced by those who saw them to be stains of blood. M. Barruel and another medical jurist were required to determine the nature of the stains, and the examination was made before a magistrate in the presence of the accused. They were clearly proved, by these and other experiments, to be spots produced by the citrate of iron. It appeared on inquiry that the knife had been used by some person, a short time previously, for the purpose of cutting a lemon; and not having been wiped before it was put aside, a simple chemical action had gone on between the acid and the metal which had given rise to the appearance. This case certainly shows that physical characters alone cannot be trusted in the examination of these suspected stains. Stains of the *citrate of iron* may be thus distinguished:—The substance is soluble in water, forming, when filtered, a yellowish solution, totally different from the red colour of blood under the same circumstances. The solution undergoes no change of colour on the addition of ammonia. If in the state of persalt, it is rendered blue by guaiacum. It is unchanged in colour, but may be partially coagulated at a boiling temperature, and it is at once identified as a salt of iron by giving a blue colour with the ferrocyanide of potassium. I have observed that the spots of the citrate of iron on knives (for they are not found on other weapons) are often soft and deliquescent, while those of blood are commonly dry and brittle.

It is not always easy to distinguish by sight a stain of blood on a weapon from a mark produced by common *iron-rust.* When suspicion exists, marks are pronounced to be due to blood, which under other circumstances would have passed unnoticed. One source of difficulty is this: the iron-rust on an old knife is often mixed with some article of food, or even with blood itself. We must here pursue the same mode of examination as if the stain were of blood; we macerate the

weapon, or a portion of the coloured deposit scraped from the surface, in a small quantity of distilled water, and filter the liquid. If the stain is due to iron-rust alone, this will be separated by filtration, and the liquid will pass through colourless. The absence of blood is thereby demonstrated: for I need not here consider the objection that the weapon may have been exposed to heat, and the blood-stains have been thereby rendered insoluble in water. If we now digest the brown undissolved residue left on the filter in hydrochloric acid free from iron, we shall obtain a yellowish solution, which will give with the ferrocyanide of potassium a blue colour—Prussian blue.

In old blood-stains on rusty weapons, blood and oxide of iron are necessarily intermixed. In order to detect and separate them the following plan may be adopted. Scrape off portions of the supposed dry blood and rust into a porcelain capsule. Moisten the substance with water and let it stand covered. If blood is present the water will acquire a reddish-brown hue, and the addition of guaiacum and peroxide of hydrogen will show whether the red colour is owing to blood. The effect is strongly marked when the water is allowed to evaporate to dryness and leave a reddish stain on the white porcelain. The guaiacum and peroxide of hydrogen have no action upon iron-rust, but the particles of dried blood acquire a blueish colouration around them, and are thereby clearly distinguished from the particles of rust. The guaiacum and peroxide applied to a film of water on which the rusted weapon has been placed will give a blue colour if blood is present, otherwise not. By this process, blood was readily detected on a rusty knife used in an act of murder committed ten years previously. (*Case of Gardner*, p. 491.) No blood could be seen on the blade with the aid of a lens.

The following case was referred to me for examination some years since. A man was suspected of murder, and there were on his shirt some stains, which were supposed to have been produced by blood. Around the collar and upper part of the shirt there was a large and somewhat deep pinkish-red stain, in some respects resembling washed blood. This appeared to be an unusual situation for blood to be found sprinkled; and upon testing the stained linen by the process for blood, the colour entirely resisted separation by water, and was turned of a slight crimson tint by ammonia. The stain was thus proved not to be due to blood. On inquiry, it was ascertained that the man had worn round his neck a common red handkerchief during a wet night, and while taking violent exercise! The reddish-coloured stain was thus accounted for. There were, however, some other marks on the shirt which required examination, as there was a very strong suspicion against this man. These were on the sleeves, at those parts which would be likely to receive stains of blood if they had been rolled or turned up at the wrists; and it was clearly ascertained that the murderer in this case had used a quantity of yellow soap in washing his hands. The stains were of a brownish colour, without any shade of red; they were faint in parts, and diffused, conveying the impression that an attempt had been made to wash them out. So far as external characters were concerned, it was difficult to say whether they had been produced by blood or not. On examining the parts of the shirt corresponding to the armpits, stains precisely similar were there seen, evidently resulting from cutaneous perspiration, since the suspicion of blood being effused on these parts of the shirt, under the circumstances, could not be entertained. Slips of linen from the stained portions of the sleeves were digested in water. In twenty-four hours the stains were entirely removed, and the lower stratum of water in each tube had acquired a straw-yellow colour. There was not the least shade of a red or brown colour. The solution was wholly unlike that produced by blood under any circumstances; it was not changed in colour by ammonia, or by a heat of 212°; but it acquired a faint opalescence on the addition of nitric acid. These results not

only indicated the absence of blood, but showed that the stains were due to cutaneous perspiration issuing from a dirty skin through a dirty dress. The stains on the parts corresponding to the armpits could not be ascribed to blood, and from the similarity in physical and chemical properties it was impossible to attribute those on the sleeves to blood. It happened, however, that a large pocket-knife, with numerous dark red stains on the blade and between the layers of the handle, was found upon this man; and this was also sent for examination. Several persons who saw the knife pronounced that the marks were due to blood. The stains were composed of some soft viscid matter, which gave out ammonia when heated, and left a residue of peroxide of iron. On digesting the matter in water no portion was dissolved; and it was, therefore, evident that they were due not to recent blood, but to a mixture of some animal matter, probably food, with iron-rust. These results were somewhat in the man's favour—at least, they removed what was considered to be a strong substantial proof of his guilt. He was subsequently tried for the murder, and acquitted on an alibi, established by the evidence for the prosecution.

In the case of Mr. Briggs (*Reg.* v. *Müller*, Central Crim. Court, October 1864), a question arose whether there was dried coagulated blood upon a life-preserver, which the prisoner might have employed. The weapon consisted of a heavy mass of lead, enclosed in a network of string, and secured to a whalebone handle. There was a substance on the network resembling dried blood. When this was removed and placed in contact with water, it was not dissolved, and, under the microscope, presented the appearance of brown flakes, which gave no colour to the surrounding liquid. On applying a red-hot platinum wire to the supposed coagulum, it melted, and gave off the smell of resin. It was part of a resinous composition which had been used for securing the lead to the network; it had become softened by heat, and had oozed out between the meshes. No blood could be detected in any part.

From the foregoing remarks, we may justly infer that the chemical analysis of suspected spots or stains on weapons and clothing is by no means an unimportant duty. If we cannot always obtain from these experiments affirmative evidence, they often furnish good negative proof, and thus tend to remove unjust suspicions against accused parties. There is one circumstance, however, of which a medical jurist is entitled to complain, namely that evidence should be received on matters of this kind from police-constables or other non-professional persons. No confidence should be placed in an opinion derived from physical characters only. On the occasion of the murder of *Eliza Grimwood*, in June, 1838, committed as it was under circumstances of the greatest mystery, and the perpetrator of which has not been discovered, the examination of suspected marks resembling blood, became rather an important part of the inquiry, but it was most improperly conducted. The finger-plates of the door of the room, in which the murder was perpetrated, presented some dark stains, supposed to have been produced by the bloody hand of the murderer in the act of escaping. The only test to which these were submitted was, that the magistrate, before whom the case was heard, tried to rub off some of the stains with a piece of blotting-paper, but did not succeed; and he expressed his opinion, that, if they were blood-stains, they had been wiped! It is easy to perceive to what results superficial examinations of this kind may lead.

Detection of fibrin.—In the process for examining blood-stains, it has not been thought necessary to refer to the properties of fibrin. Fibrin forms about 1-500th part of human blood; it exists in the blood of all warm-blooded animals. The other animal liquids in which it is found are the chyle and lymph. It is the chief constituent of muscular fibre. When the blood is in sufficient quantity, a pale film of fibrin may be left upon the stained sub-

stance, after the colouring matter has been removed by digestion in water. Small quantities of fibrin are not easily identified by chemical properties. Animal fibrin so closely resembles coagulated albumen and gluten, that it cannot be distinguished from them by chemical tests. Hence, unless evidence of the existence of red colouring matter is obtained, the presence of fibrin cannot be relied on; and if this is obtained, the demonstration of the properties of fibrin is unnecessary, for there is no red colouring matter which, under due precautions, can be mistaken for that of blood. Evidence on this subject was tendered in the case of *Reg.* v. *Reed* (York Winter Assizes, 1847), but it was not well received by the Court. It has been supposed that the demonstration of the presence of fibrin in a blood-stain would enable us to say whether the blood had been effused from a living or dead body; but, admitting that the existence of fibrin in a small quantity of dried blood upon an article of dress could be indisputably established, this fact would not enable us to give a conclusive answer to the important question above suggested. If the quantity of blood examined be comparatively great, and no fibrin can be procured from it after complete digestion in cold water, it is probable that this blood has not come from a living body, and that it is merely a mixture of red colouring matter and serum, like that found in the vessels of the dead body after perfect coagulation. But the experimentalist must bear in mind that small stains of blood will commonly leave no perceptible traces of fibrin. A well-marked stain of blood will not weigh when dry more than one-tenth of a grain. According to the average proportion the stain would not contain more than a mere trace of fibrin. On the other hand, if fibrin were clearly obtained, it would be by no means proved that the blood yielding it had issued from a *living* body. Until the blood has coagulated, it retains fibrin; and coagulation seldom commences in the dead body until after the lapse of three or four hours, although, if removed from the body, it speedily becomes solid.

Arterial and Venous blood.—It is not possible to distinguish *arterial* from *venous* blood by any physical or chemical characters, when it has been for some days effused, and is in a dry state upon articles of dress, furniture or weapons; but this, in medico-legal practice, is not often a subject of much importance, since there are few cases of severe wounds, either in the throat or other parts of the body, in which the two kinds of blood do not escape simultaneously. The most striking and apparent difference between them, when recently effused, is the *colour*; the arterial being of a bright scarlet, while the venous is of a dark red hue; but it is well known that the latter, when exposed to air for a short time, acquires a florid red or arterial colour; and the two kinds of blood when dried, cannot be distinguished chemically by any known criterion. If a coat, or other stuff, stained with blood, were of a dark colour, the liquid would be absorbed and speedily lose its physical characters. Arterial blood contains more fibrin than venous, and coagulates more firmly. The microscope shows no appreciable difference in the blood-corpuscles, and chemistry does not enable us to apply any test so as to make a satisfactory distinction between them. In this deficiency of microscopical and chemical evidence an attempt has been made to establish a distinction by noticing the physical appearances of the blood stain. Thus, it is alleged, the arterial blood will be indicated by its being *sprinkled* over surfaces upon which it has fallen, while the venous blood is always poured out in a full stream. In most wounds which prove fatal by hæmorrhage, the blood is poured out simultaneously from arteries and veins. The sprinkled appearance of the blood, when it exists, will, cæteris paribus, create a strong presumption that it was poured out from a *living* body, for after the heart has ceased to act the arteries lose the power of throwing out the blood in jets. This mode of dis-

tinguishing arterial from venous blood was adduced as evidence in the case of *Sellis*, who destroyed himself after having attempted to assassinate the Duke of Cumberland. There was the appearance of sprinkled blood on the coat-sleeve of Sellis, and it is stated that the temporal artery of the Duke had been wounded. Sir Everard Home thence inferred that Sellis had attacked the Duke, and wounded the artery, which had led to the sprinkling of the sleeve. ('Will's Circ. Ev.' 89.) This method of distinguishing the two kinds of blood, therefore, may be occasionally available for practical purposes; but it must be remembered that accident may lead to the sprinkling of blood from a small vein which has been wounded, while blood may be poured out in considerable quantity from an artery, especially if large; and if it fall on one spot at a short distance, it may produce a soaked appearance. The sprinkling may be expected only when the wounded artery is small, and the blood is effused at a distance. This is a fact which a medical jurist should not overlook, although, for the reasons stated, too great a reliance must not be placed on it. The spots of blood, if thrown out from a living blood-vessel, speedily consolidate, and the fibrin with the greater portion of the colouring matter, is found of a deep red colour at the lower part of the spot, the upper portion being of a pale red. The lower and thicker part has commonly a shining lustre, as if gummed, when the spot is recent, and when it has been effused upon a non-absorbent surface. This glazed appearance is, probably, given by the evaporation of the aqueous, and the rapid desiccation of the albuminous portions. In *Reg.* v. *Spicer* (p. 521), there was a wound of the temporal artery of the deceased woman. A brick in the wall, opposite to the spot where the wound was inflicted, presented the appearance shown in the annexed illustration (fig. 109). The size and direction of the spots vary according to the distance of the person wounded, and the direction in which the spurting has taken place against the surface. When blood falls upon porous articles of clothing, as linen or cotton, it is absorbed, and produces a dull stain. In dark-coloured articles of dress, it is sometimes difficult by daylight to perceive these stains. The part appears stiffened, and has a dull red-brown colour, which is sometimes more perceptible when seen by the reflection of the light of a candle.

Fig. 109.

Spots of arterial blood sprinkled on the face of a brick from a wound of the temporal artery (*Reg.* v. *Spicer*, Berks Lent Assizes, 1846).

In trusting to the coagulation of the sprinkled blood as evidence of its escape from a living vessel, it must be remembered that three or four hours may elapse before it coagulates in the healthy body after death. Hence blood which has escaped from a recently dead body, although it would not be found diffused as if by spurting, might, in so far as coagulation is concerned, assume the appearance of having been effused from a living body. On this fact Donné has founded a process for determining whether a person is really dead. ('Cours de Microscopie,' p. 54; see also *ante*, p. 63.) The mere fact of the blood in blood-stains being found coagulated, does not prove that the person was actually living when the blood was effused. It merely shows that he was either living or but recently dead. Some states of the living body appear to favour and others to prevent the coagulation of the blood after death. Lehmann asserts that, in the bodies of persons who have recently died from violent inflammations, excepting those which affect the brain and spinal cord, the blood after death has a thick fluid character, a reddish-brown colour and readily coagulates. It be-

comes bright red on exposure to air. In pyæmia and some fevers, the blood is thinly fluid, uncoagulable and of a dirty brownish colour. ('Physiological Chemistry,' vol. 2, p. 206.)

In spite of the great advances made in the construction and use of the microscope, there is no method known by which the blood of a man can be distinguished from that of a woman, or the blood of a child from that of an adult. The blood of a child at birth contains less fibrin, and forms a thinner and softer coagulum than that of the adult. A medico-legal question has arisen, on more than one occasion, whether there were any means of distinguishing *menstrual* blood from that of the body generally. This liquid contains fibrin although the proportion is less than in venous or arterial blood, red colouring matter, and the other constituents of blood. The only differences noticed are of an accidental kind: 1st, that it is acid, owing to its admixture with vaginal mucus; and 2nd, that under the microscope it is mixed with epithelial scales, which it has derived from the mucous membrane in its passage through the vagina. (Donné, 'Cours de Microscopie,' p. 139.) In the bodies of women who had died suddenly while menstruating, Dr. Webber found coagulated blood upon the uterine mucous membrane. If, therefore, menstrual blood does not coagulate, it is simply because it has already coagulated within the uterine cavity, and cannot do so again; it is more fluid than ordinary blood, because, during its trickling descent, it becomes mixed with watery uterine, and vaginal mucus. ('Schmidt's Jahrb.,' 1847, 7, 139.) A case occurred in France, which induced the Minister of Justice to refer the consideration of this question to the Academy of Medicine. The reporters, M.M. Adelon, Moreau, and Le Canu, came to the conclusion that there were no means of distinguishing menstrual blood dried on clothing, from that which might be met with in a case of infanticide or abortion. ('Ann. d'Hyg.' 1846, 1, 181.)

The *Guaiacum process.*—Some remarks were made in the first edition of this work respecting the use of guaiacum as a test for blood. It was first proposed by Van Deen, a Dutch chemist, but it attracted little attention until 1863, when Van Deen's experiments were made the subject of a minute critical examination by Dr. Liman of Berlin. ('Neue Versuche zur Erkennung von Blutflecken und zur Prüfung von Van Deen's Blutproben.' Casper's 'Vierteljahrsschrift,' 1863, 2, 193.) Van Deen employed a mixture of oil of turpentine and tincture of guaiacum. He found, on applying this mixture to a blood-stain, that the liquid acquired a blue colour as the result of the oxidation of the resin. He attributed this chemical change to the presence of ozone in the oil of turpentine, but as turpentine, in the absence of blood, will produce no such effect, and as bodies containing ozone (ozonides) render guaiacum resin blue when blood is not present, it is clear that the oil of turpentine does not act by reason of its containing ozone. As Van Deen and Liman employed a mixture of the tincture of guaiacum and oil of turpentine, their method was open to the serious objection that a variety of substances which oxidize guaiacum resin by direct contact, might be mistaken for blood. Dr. John Day, of Geelong, Australia, was the first to demonstrate by numerous experiments the proper mode of employing the guaiacum test. ('Australian Med. Jour.' May 1867, and Nov. 1869.) Schönbein had already discovered that the resin was blued by blood in the presence of a principle which he called antozone (which had no action on the resin), and this principle was soluble in ether. Schönbein's theory was that antozone in contact with blood was changed into ozone, and blued the resin; but whether this theory be or be not correct, the facts remain—1, that the red colouring matter of blood undergoes no change in tincture of guaiacum; 2, that it undergoes no change of colour

when mixed with pure peroxide of hydrogen dissolved in ether (autozone); 3, that in the presence of these two solutions, the red colouring matter of blood immediately renders the guaiacum resin blue; 4, that no red colouring matter, animal or vegetable, excepting the red of blood (hæmatin), has been found to produce this blue coloration of guaiacum in the presence of peroxide of hydrogen. On these four results a more perfect method of testing has been founded by Dr. Day than that practised by Van Deen and Liman. The mode in which the test should be employed has been already described (p. 527), and the results, when the right course is pursued, are highly satisfactory.

It may be here observed that the alcoholic solution of guaiacum resin should be fresh made from the inner or unoxidized portions of resin, and the solution kept in the dark. The pure ethereal solution of peroxide of hydrogen is procurable under the erroneous name of ozonized ether. Its fitness for testing may be determined by adding to it a small quantity of acid chromate of potash strongly acidulated with sulphuric acid, when blue perchromic acid is formed, and rises to the surface dissolved in the ether.

I have verified by experiments on numerous samples of blood, taken from the four classes of animals, the correctness of Schönbein and Dr. Day's results. In one instance only did I find that guaiacum resin was blued by the red colouring matter of blood before the addition of peroxide of hydrogen; but a subsequent examination of another portion of the same sample, satisfied me that this must have been owing to some foreign matter mixed with the blood. (See 'Guy's Hospital Reports' for 1867, p. 432, and for 1870, p. 274.)

M. Lefort has objected to this process on the ground that the resin of guaiacum is blued by an 'unlimited' number of substances ('avec un nombre presque illimité de substances appartenant aux trois règnes de la nature.' 'Ann. d'Hygiène,' 1870, 2, 432); but this objection is irrelevant and misleading. Schönbein and Dr. Day have both proved clearly that the colouring matter of blood does not cause a blueing of guaiacum resin, and therefore it could not possibly be mistaken for any one of the 'unlimited' number of substances, having nothing in common with blood, which change the colour of this resin. It is always proper in practice to employ the guaiacum first. If this is blued, then other methods of detecting blood should be resorted to. Out of a large number of cases I have not met with one instance during six years in which this blueing of the guaiacum by direct contact formed any obstacle to the detection of blood.

M. Lefort, in dealing with this subject, forgets that in medico-legal researches the problem is to distinguish the *red* colouring matter of blood from other *red* colouring matters. He thinks that *colourless* saliva and colourless mucus may be mistaken for blood, because, according to him, they are blued by the guaiacum and peroxide, like blood. Assuming that he is correct (although his results are not in accordance with my experiments), no medical jurist, not even a police-constable, could mistake colourless stains of these liquids for stains of *red* blood. Unless there were some visible marks bearing a resemblance to blood, the articles of clothing would not be brought to him for the purpose of analysis.

The same remarks apply to the colouring matter of bile, which, according to Dr. Jamieson ('Australian Med. Jour.' Oct. 1869), produces slowly a blueing of the guaiacum resin in contact with peroxide of hydrogen. In practice, stains of bile are so strongly marked by their peculiar yellow colour and special tests, that no one competent to undertake such investigations could fall into an error of confounding them with stains of blood. The mistakes which have arisen respecting blood on clothes have been chiefly traceable to the presence of stains derived from red fruits and flowers, artificial red dyes, and some red mineral substances,

such as red oxide of iron. M. Le
colouring matter of wine gave a b
guaiacum and peroxide, but this wa
p. 438.) It is the very essence of t
is immediate, or that it takes plac
or ought to be placed upon any ch
production, since the resin alone, o
under long exposure to air. If thi
would be in all cases fallacious.

The test operates equally well o
as well as very diluted blood, even
junction with the spectroscope, it
washed blood (page 532). Provided
remains, the change to blue is perc
no indication of a red colour—what
tests—it would be unsafe to affirm t
the proper precautions being obser
blueing of the guaiacum resin in the
say that the mark or stain is *not* own
avoid relying upon one test, and th
required for the action of guaiacum
tion for the spectroscope and chemic
objection could be fairly raised agai

Spectrum analysis. Spectral test.—
discovery made by Dr. Stokes on t
blood was briefly referred to. ('Pro
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Sheffield and other observers, and sp
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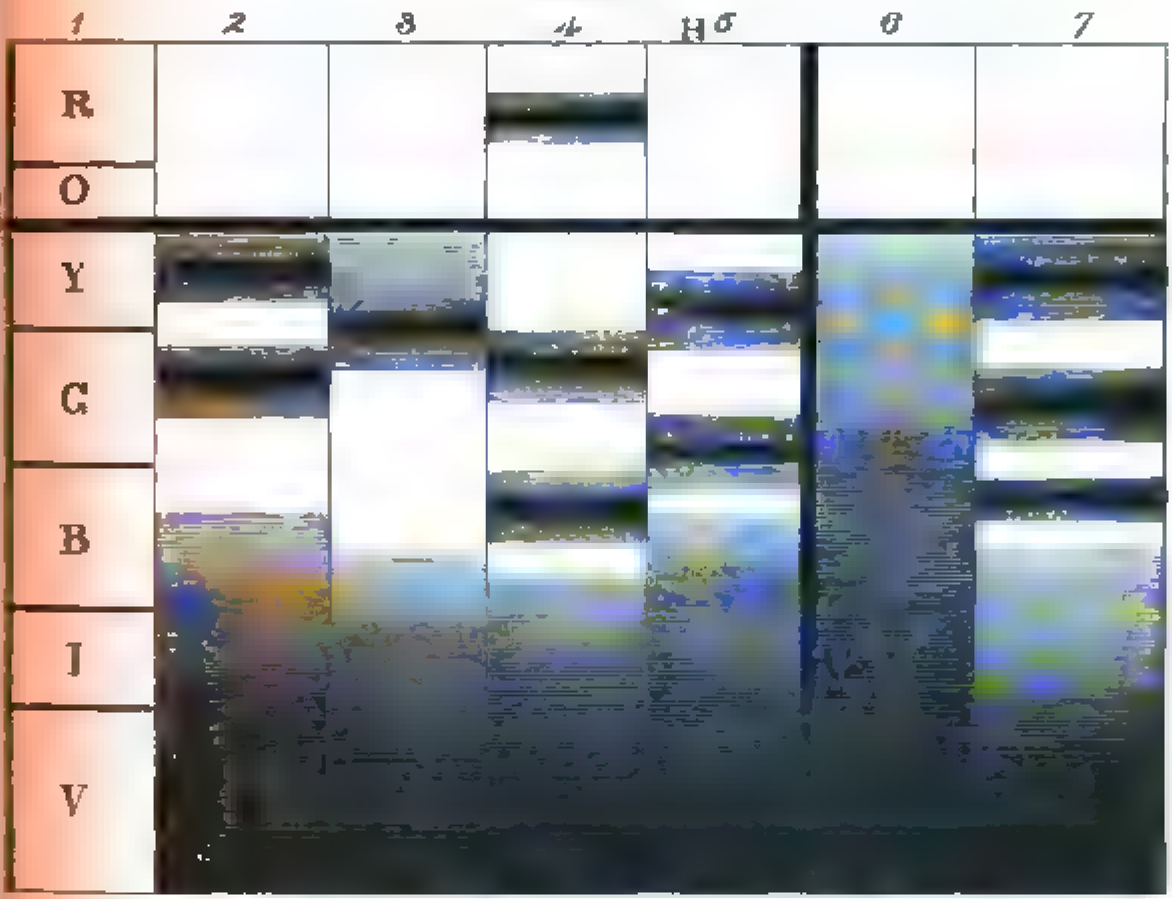
already described. We simply anal
the red colouring matter, and with a
microscope, we notice whether the
change. If the red liquid owes its
dark absorption-bands will be seen
spectrum (col. 2, fig. 110). These are situated respectively at the junction of the yellow with the green rays, and in the middle of the green rays. If the blood is quite recent and of a bright red colour (scarlet hæmatin, or cruorine) the two absorption-bands are distinct and well defined (col. 2). A good light, either artificial or daylight, is required; the coloured liquid should be clear and of sufficient intensity, and the spectrum apparatus properly adjusted. The blood may be placed in a reduction tube, or in a glass cell contrived for the purpose. The spectral eye-piece allows of two tubes being examined at once, and it is desirable to have a specimen of blood mounted for comparing the actual spectrum of blood with that of the suspected liquid.

In the course of an hour, in warm weather, and after a day or two in cold weather, the blood in the tube undergoes a remarkable change. It loses its scarlet and acquires a purple colour (purple hæmatin). In this state the two bands appear blended, and one broad black band only is seen (col. 3). The blood appears to undergo deoxidation, for on removing it and shaking it with air in the tube, it becomes again bright, and the two black bands reappear. Blood which had been kept one year sealed up gave one broad black band covering partly the orange, the whole of the yellow, and a portion of the green rays. There was also a band crossing the red rays of the spectrum.

When the blood by long exposure to the air has undergone chemical changes, it ceases to give any well-defined absorption bands. In a sample of sheep's blood which had been dried and kept in a bottle about twelve years, the solution appeared to split the spectrum into four nearly equal parts: red—one black absorption-band (occupying the orange-yellow and part of the green spaces), green and blue—the violet rays, as in most of the blood-spectra, being absorbed.

Fig. 110.



1. The spectrum with the [illegible] At [illegible] O, with the yellow, Y, is the sodium line, D, running through the whole of the spectra, and forming a distinct boundary-line for some of the absorption bands.

2. Spectrum of fresh or recent blood, or of blood dried in a pure atmosphere (scarlet or oxidised hæmatin, cruorine, hæmoglobin).

3. Spectrum of purple or deoxidised blood [illegible] This is a common appearance presented by old blood, which has become more or less of a red-brown colour.

4. Spectrum of blood of old date, or of blood exposed to air more or less impure; blood which has undergone spontaneous changes on articles of clothing, weapons, &c. (brown hæmatin, methæmoglobin).

5. Spectrum sometimes found in recent blood-stains, but producible from No. 4 by deoxidation, spontaneous or otherwise. These four spectra represent blood as it may be met with on articles of clothing, weapons, and furniture. These spectra have been obtained directly from blood or blood-stains, without the intervention of any chemical reagents.

6. Spectrum of sulphocyanide of iron, a mineral colour resembling that of blood, and formerly supposed to be the colouring principle of this liquid. The spectrum proves that it has nothing in common with blood.

7. Spectrum of a solution of alkanet in alum, a red mineral and organic liquid presenting two absorption bands like those of recent blood (col. 2), but combined with a third between the green and the blue.

For information respecting the effects produced by chemical reagents on the spectra of blood, the reader is referred to Mr. Sorby's papers in the 'Medical Press' for July 1871, and the 'Monthly Microscopical Journal'; and Preyer's work, 'Blutkrystalle,' Jena, 1871. In the latter work the effects produced by a large number of chemical substances are described and delineated.

The single broad band formed in purple hæmatin generally extends from the sodium line to one half of the green (col. 3). It is sometimes represented as beginning below the sodium line. This line, which forms an admirable boundary in the spectrum, is obtained readily by placing a spirit-lamp with a small quantity of salt on the wick, below the stage of the microscope.

By artificial processes, the addition of certain chemicals to blood, the effects of oxidation and deoxidation may be imitated, and as many as seven different spectra of blood have been described by Mr. Sorby. For a description of these methods of applying spectral analysis I must refer the reader to Mr. Sorby's paper in the 'Quarterly Journal of Science' for April 1865, vol. 2, p. 198; and the 'Popular Science Review,' 1866, vol. 5, p. 76; the 'Guy's Hospital Reports' for 1870, p. 274; and a paper by Dr. Herapath in the 'Chemical News' for 1868, vol. 1, p. 124.

There can be no doubt that in the hands of a competent person, and one skilled in micro-spectral observations, this optical method will enable him to discover the minutest traces of blood, provided any red colouring matter remains. Thus Mr. Sorby states that a spot of blood only one-tenth of an inch in diameter, or a quantity of the red colouring matter amounting to no more than the 1,000th part of a grain, is sufficient to give conclusive evidence of its presence by spectrum analysis! Mr. Sorby thus detected blood in the form of deoxidized hæmatin on the rusty blade of a knife with which the murder of Mrs. Gardner was committed in 1862, after the lapse of ten years (p. 491). Blood-stains which have been washed in water, and blood which has even been boiled or heated to 212°, may be thus detected. In the latter case ammonia, with the aid of a gentle heat, should be employed to dissolve the matters rendered insoluble by boiling. Spectral analysis does not enable us to make any distinction beyond that of recent and old blood, and this distinction cannot be so drawn as to enable us to fix a specific or even an approximate date. Certain accidental conditions may rapidly produce on blood the same effect as exposure to air for a long period of time. It indicates no distinction in the blood of the sexes, of the fœtus and adult, or in the blood of man and animals. As a corroborative process it furnishes most valuable and trustworthy evidence, and there is no case in which blood admits of a chemical examination in which spectral analysis does not admit of a safe application before the chemical tests are applied. Dr. Falk describes it as the most certain, satisfactory and simple process for detecting blood in medico-legal cases. (Horn's 'Vierteljahrsschrift,' 1867, 1, 354.) For separating the blood more readily from stains on clothing he advises, in preference to water, the employment of a solution of iodide of potassium, in the proportion of one part to four parts of water.

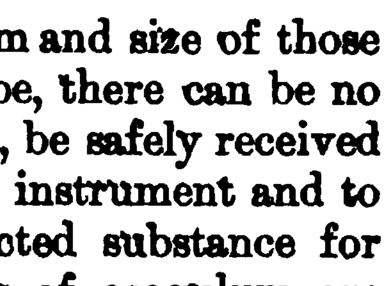
The question here arises, Are there no objections to this optical test? Are there no red colours which, when traversed by light and sent through a prism, will produce absorption-bands similar to those of blood. Having tried all the ordinary red colours, animal, vegetable, and mineral, I have found none which produce the absorption-bands of blood; and this also is the result of Mr. Sorby's more extensive experience. A decoction of cochineal with ammonia has been said to possess similar optical properties, but this is not in accordance with my observation. I have found in this liquid one broad black band obliterating entirely the yellow and orange rays of the spectrum. A solution of alkanet in alum (fig. 110, col. 7) gives two absorption-bands which might be mistaken for those of blood, but there is a third band at the end of the green rays where joining the blue (fig. 110, col. 7). Even if this were overlooked the properties of such a solution are wholly different from those of blood, and the liquid could not be mistaken for it. No prudent witness would rely upon a spectral examination only, and thus any difficulty on this ground would be removed. This answer equally applies to another objection, namely, that a prepared solution of *Turacine*, a red colouring principle in the feathers of the Cape Lory (*Turacus albocristatus*), presents two absorption-bands, similar to those of blood in form and position. ('Student's Intellectual Observer,' April 1863, p. 165.) An admirable summary of this subject is given by W. Preyer

('Blutkrystalle.' 'Untersuchungen' von W. Preyer, Jena 1871). This work includes thirty-two coloured spectra of blood under its different conditions, showing how the absorption-bands vary in size, position, and number, according to the proportion of red colouring matter present, or according to the nature of the substance with which the red colouring matter is mixed.

Preyer makes a distinction in the use of the spectroscope, which it will be well for a medical witness to bear in mind. The absence of the absorption bands in a red coloured liquid, however much it may resemble blood, proves that it is *not* blood, but some other red colouring matter. This direct method, *i.e.* the demonstration by two absorption-bands of the presence of undecomposed colouring matter (hæmoglobin) has however only a limited application. In practice the proof of the presence of blood by the spectroscopic examination of the products of its decomposition by chemical agents, is not satisfactory. (Op. cit. p. 112.) If certain spectra of an artificial kind produced by chemical agents, are relied upon as absolute proof of the presence of blood, the witness must be prepared to state from personal observation, the effect of these chemicals when employed with other red colouring matters. In the hands of experienced observers this difficulty would not arise.

Microscopical evidence. Blood-corpuscles.—Hitherto the microscope has been described as an aid to the examiner in drawing a distinction between the appearances presented by blood-stains in the dry state, and those caused by other substances. Its use, however, extends much beyond this. The spots or stains may be so small as not to admit of removal for the purpose of applying chemical tests. If an examination of a dry stain with a low power (20 or 30 diameters) justifies further proceedings, we may then employ the microscope for the purpose of detecting those peculiar bodies on which the colour of red blood is known to depend. The red colouring matter of blood consists of minute coloured cells or corpuscles, floating in a clear liquid (serum). The annexed engravings (figs. 111, 112) show the form in the class Mammalia. *a* represents the circular form, when seen in front, the shaded portion being a depression which under a certain disposition of the light assumes the appearance of a solid and opaque nucleus; *b* represents a corpuscle seen edgewise, in which case it presents somewhat the shape of a biconcave lens. It owes this form to the central depression on each face. Other red colouring matters, such as madder, cochineal, or lac, do not owe their colour to independent cells or corpuscles. Hence, if corpuscles, of the form and size of those found in mammalian blood, are visible under the microscope, there can be no doubt that the liquid is blood. Such evidence can, however, be safely received only from one who has been accustomed to the use of this instrument and to the examination of blood. In order to examine the suspected substance for corpuscles, the best plan of proceeding, when the particles of coagulum are very small, is to breathe several times on a glass-slide, then place the small fragments of coagulum on the slide, and again breathe over them. A slip of thin glass may then be laid upon them. If they consist of blood a red margin will soon appear, and in the fluid portion, by the aid of a magnifying power of from 300 to 500 diameters, some of the corpuscles of the blood may be recognized. They are seldom so perfectly spherical as in the fresh state, and they appear small, and frequently shrunk or corrugated. In some cases only fragments of the envelopes can be seen. This method has been suggested by Dr. Erpenbeck. (Casper's 'Vierteljahrsschrift,' 1862, 21, 259.) The condensed moisture of the breath serves the purpose of water in breaking up the particles of dried blood, without destroying the corpuscles by too much dilution. The red colour of blood is well brought out under these circum-

Fig. 111. Fig. 112



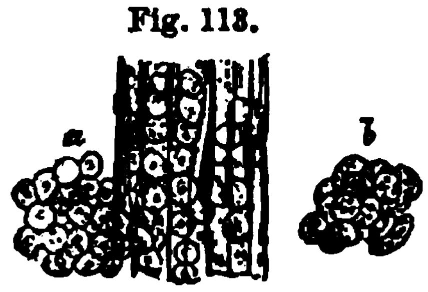
Blood corpuscle highly magnified.

stances. In thus treating cochineal, extract of logwood, kino, and other colouring matters, the appearances observed will be found wholly different.

If the suspected clot is in larger quantity, it may be removed from the stuff and placed to macerate in one or two drops of water on a glass slide. It should be covered with thin glass, in order to prevent rapid evaporation. This method of extracting the corpuscles has frequently failed, owing to the quantity of water employed having been too large. Under these circumstances, the corpuscles are distended and rapidly destroyed, while the water simply becomes coloured. It is by no means easy in all cases to obtain from dry coagula clear and distinct evidence of the presence of these corpuscles, especially when the blood is old. In drying, the blood-cells lose their form, and they do not readily resume it when again moistened. Unless they are seen after a short maceration in a very small quantity of water, it is probable they will not be seen at all. To accelerate their separation various chemical liquids have been employed. Thus strong solutions of sulphate of soda and common salt, as well as liquid albumen and serum, have been employed as fluid media for breaking up the dried clots of blood; but there are disadvantages attending the use of these solvents. A mixture of glycerine and water in the proportion of one part by measure of glycerine, to three or four parts by measure of distilled water, will be found preferable. The quantity of distilled water should be such as to bring the mixture to the specific gravity of serum, 1028. A solution of arsenious acid, in the proportion of four grains to an ounce of distilled water, as recommended by Dr. Kunze, is also a rapid solvent of the coagula. When this is used, the examination should take place as soon as the liquid begins to be coloured at the margin, or the corpuscles may be destroyed, and only fragments of their envelopes seen. MM. Lesueur and Robin have adopted the following plan, which they affirm to be successful for the detection of mammalian blood. A portion of the suspected coagulum is scraped off the stained substance into a solution of sulphate of soda, made slightly alkaline by the addition of a little caustic soda, and it is then examined under the microscope, with a power of 520 diameters. At first the substance appears entirely homogeneous, but in half an hour it swells, and in another half-hour globules are formed, which can be separated by gently rubbing the glass slides one upon the other. These observers thus identified globules as those of mammalian blood, *i.e.* of animals which suckle their young. ('Chemical News,' 1850, 2, 295.)

In reference to stains on clothing, if they present any appearance of dry coagula, these should be carefully scraped off, and treated in the manner above described. If no portions of solid coagula can be procured, there will be but little hope of obtaining evidence of the presence of corpuscles in the suspected stain. The stained portion may be cut out and macerated in a small quantity of water. Under these circumstances the corpuscles may be sometimes seen aggregated, or in groups, in the fibres of the stuff, as in the subjoined engraving, fig. 113, in which the stain of blood was on a shirt. (Briand's 'Manuel de Méd. Lég.' 1863, p. 747.)

Fig. 113.



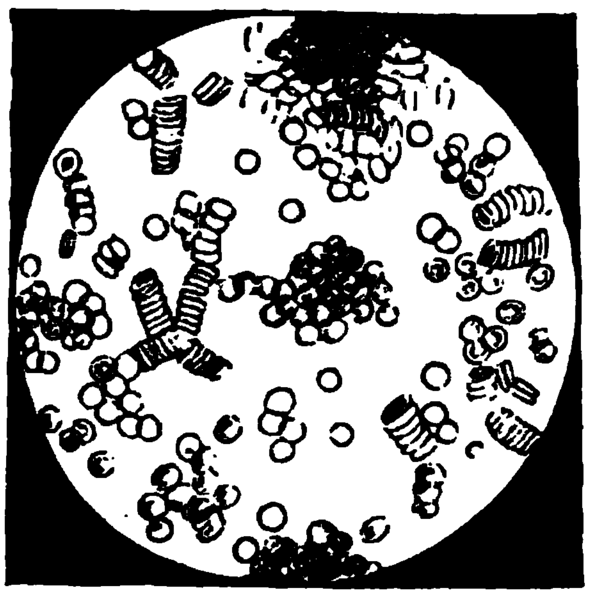
a, Corpuscles of blood in linen fibre; *b*, a group detached.

The illustrations on page 545 show the appearances presented by blood-corpuscles, when examined with a power of about 300 diameters, and under different methods of treatment. The first illustration (fig. 114) is from an engraving in Lehmann's 'Physiological Chemistry.' It represents the appearance of a drop of healthy human blood. The red blood-cells are partly detached, partly united in rolls, and partly in irregular clusters. In the vacant spaces between them there are delicate threads of fibrin. The outlines of the blood-cells are rendered in some instances indistinct, by reason of this web of fibrin about them.

In fig. 115 the corpuscles are seen free from fibrin. Only a small portion

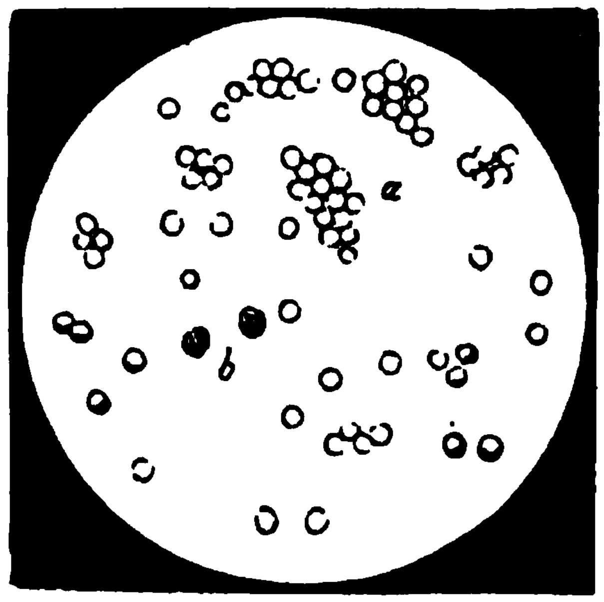
of those which were in the field have been engraved. They are seen detached and in groups; those which are shaded are the white corpuscles of the blood. They are not so well-defined in form, and present an irregularity of surface, by which they may be distinguished from the coloured blood-cells.

Fig. 114.



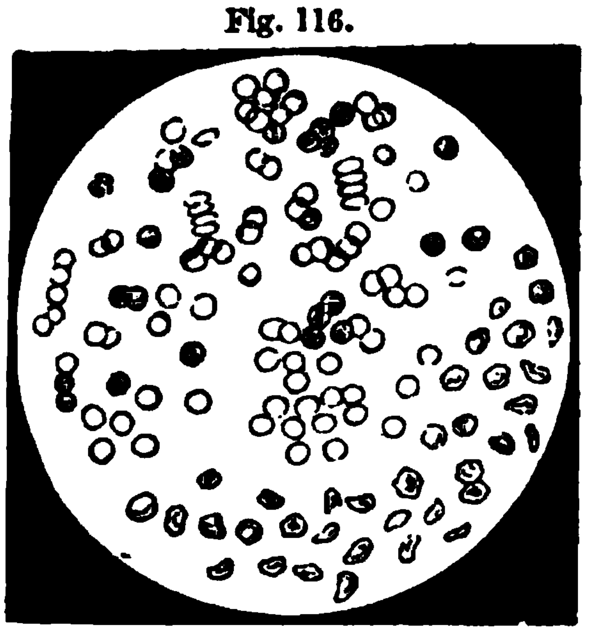
Human blood-corpuscles with fibrin.

Fig. 115.



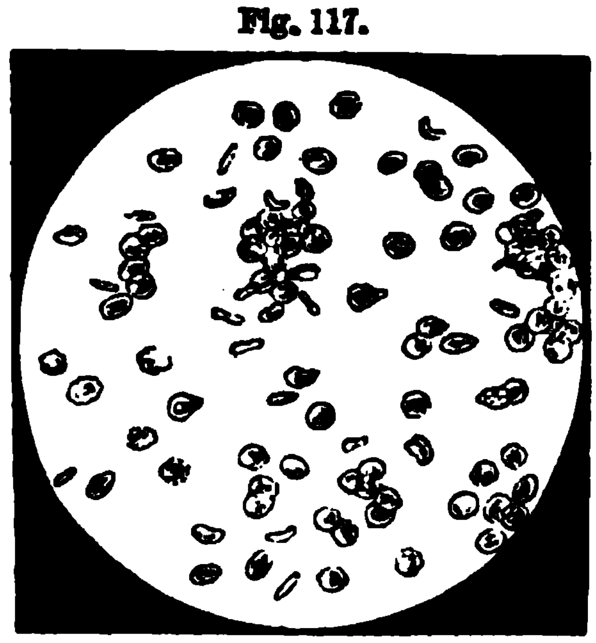
Human blood-corpuscles from a dried specimen, magnified 319 diameters.

Fig. 116.



Human blood-corpuscles, as seen in water.

Fig. 117.



Human blood-corpuscles, as seen in a solution of sulphate of soda, which does not dissolve them.

Fig. 116 represents the appearance of the corpuscles as they are seen in water, and fig. 117 their appearance when examined after treatment with a concentrated solution of sulphate of soda. The effect of water is to alter the shape and render them spherical or globular. Water also renders them paler, and finally destroys them. In fig. 117, those corpuscles which are seen edgewise have a lenticular shape. The shaded centre is the depression elsewhere described (p. 543) and represented on a larger scale. These are taken from engravings in 'Lehmann's Physiological Chemistry.'

Blood of Man and Animals.—When marks of blood have been detected on the dress of an accused person, it is by no means unusual to find these marks accounted for by his having been engaged in killing a pig, bullock, or sheep, or in handling fish or dead game. Of course every allowance must be made for a statement like this, which can be proved or disproved only by circumstances; but the question here arises, whether we possess any *certain* means of distinguishing the blood of a human being from that of an animal. Some years since, M. Barruel and other French medical jurists affirmed that by mixing fresh blood with one-third or one-half of its bulk of strong sulphuric acid, and agitating the mixture with a glass rod, a *peculiar odour* was evolved, which differed in the blood of man and animals, and also in the blood of the

sexes. This odour, it was said, resembled that of the cutaneous exhalation of the animal the blood of which was made the subject of experiment. They hereby pretended to determine whether any given specimen of blood belonged to a man, a woman, a horse, sheep, or fish. Others, endowed with a more acute sense of smelling, asserted that they had succeeded, by this process, in identifying the blood of frogs and fleas! (See Devergie, 'Méd. Lég.' vol. 2, p. 907.) It is true that strong sulphuric acid does give rise to a particular odour when mixed with fresh blood, probably owing to its decomposing action on some of the animal principles; and it is possible that some persons may discover a difference in the odour, if not according to the sex, at least according to the animal. But, assuming this to be true, there is probably not one individual among a thousand whose sense of smelling would allow him to state, with undeniable certainty, from what animal the unknown blood had really been taken. Any evidence short of this would not be received by an English Court of Law; for it is considered better in this country, not to decide at all, than to decide on principles which are exposed to unavoidable fallacy. Besides, it must be remembered that, in general, the operator has not before him fresh blood, or blood in large quantity, but merely a diluted solution of the dried colouring matter, mixed with a small quantity of serum, and sometimes only a few small spots, yielding no perceptible quantity of solution. In a case of some importance, which occurred in Paris, the testing of blood by odour completely failed in the hands of M. Barruel and two other eminent French medical jurists, MM. Tardieu and Chevalier. The mistakes made by these experts are admitted by themselves to have been of so serious a nature as to render this mode of obtaining evidence in any future case inadmissible. ('Annales d'Hyg.' 1853, 1, 413.) For additional remarks on this subject, see paper in 'Guy's Hospital Reports,' Oct. 1851.

In a few cases, the situation of the stains on different and remote parts of the dress, back and front, as well as in concealed or covered parts, may show that the defence is inconsistent with the facts; but, in the large majority, a medical witness will be required to state whether the blood is or is not human. It has been already observed that there are no *chemical* differences between the blood of man and animals. The red colouring matter, the albumen and fibrin are the same, and chemical tests produce on them precisely similar results. Thus, neither the guaiacum process nor spectrum analysis will enable us to distinguish human from animal blood. These new methods of research simply allow us to speak to the presence or absence of the red colouring matter of blood; but on the question whether the blood has been taken from a human being, or from any warm or cold blooded-animal, they throw no light. The microscope alone can assist the inquirer in solving this difficult question, and only under certain conditions. The microscope shows physical differences in reference to the shape of the blood-corpuscles in animals of different classes; and in reference to size in animals of the same class. 1. In respect to *shape*. In all animals with red blood, the corpuscles have a disk-like or flattened form. (See fig. p. 543, *ante*.) In the mammalia, excepting the camel tribe, the outline of the disk is circular. In this tribe, and in birds, fishes, and reptiles, the corpuscles have the form of a lengthened ellipse or *oval*. In the three last-mentioned classes of animals they have a central nucleus, which gives to them an apparent prominence in the centre. The blood-corpuscles of all the mammalia, including those of the camel-tribe, have no central nucleus, and they appear depressed in the centre.

The microscope, therefore, enables an observer to distinguish the blood of birds, fishes, and reptiles, from that of a human being; and this may be of great importance as evidence. In *Reg.* v. *Drory* (Essex Lent Assizes, 1851), it was suggested in the defence, that the blood-stains on the clothes of the prisoner had been caused by his having killed some chickens. The shape of the

corpuscles negatived this part of the defence. In another case, the blood was alleged to be that of a fish; this was also disproved by the shape. Dr. Bennet states that on one occasion he was called to see a patient (labouring under bronchitis) who was spitting florid blood. On examining the sputum with a microscope, he found that the coloured blood-corpuscles were those of a bird. On his telling the patient that she had mixed a bird's blood with the expectoration, she was astounded, and confessed that she had done so for the purpose of imposition. ('The Microscope as a Means of Diagnosis,' p. 185.)

The chief microscopical distinction between the *blood of man and domestic animals*, consists in a minute difference in the *size* of the corpuscles. This, however, is only an average difference; for the corpuscles are found of different sizes in the blood of the same animal. In making use of this criterion, it would be necessary to rely upon the size of the majority of the corpuscles seen in a given area, and under the same power of the microscope. It is a curious fact that their size bears no relation to the size of the animal. Thus, in the horse, ox, ass, cat, mouse, pig, and bat, they are, on an average, nearly of the same size; the difference is so slight as to be practically inappreciable. In these animals they are smaller than in man and in several of the mammalia. The corpuscles in man, the dog, the rabbit, and the hare, are of nearly the same size. In the blood of the sheep and goat, they are smaller than in other mammalia. The size of the corpuscle bears no proportion to the age of the animal: thus in the blood of the human fœtus they are found to be as large as in that of the adult.

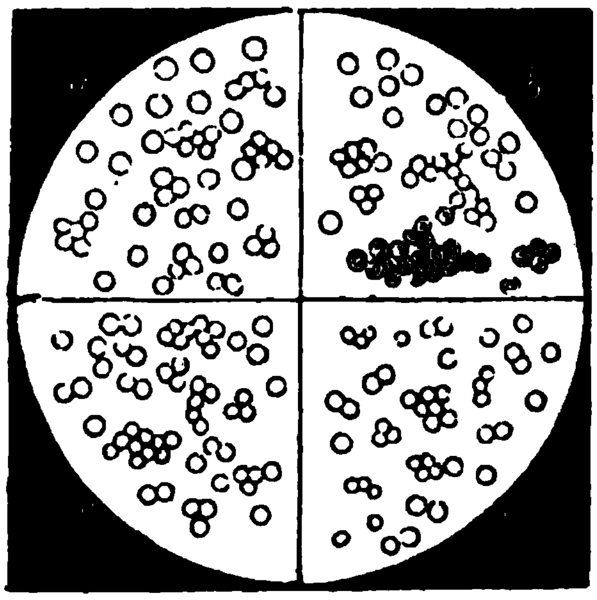
The measured diameter of the corpuscles in *human blood* varies, according to Gulliver, from 1-2000th to 1-4000th of an inch, the average size in both sexes being 1-3200th of an inch. From an examination of numerous specimens of fresh human blood, I have found the average diameter of the globules to be the 1-3500th part of an inch, the maximum size being 1-3000th, and the minimum 1-5000th of an inch. The corpuscles of human blood are larger than those of domestic animals. The subjoined measurements, in fractions of an inch, are those given by Mr. Gulliver, excepting the figures in brackets, which are from my own micrometrical observations. The average diameter is, in the dog, 1-3540th (max. 1-4000th, min. 1-6000th),—in the hare, 1-3607th (1-4000th; max. 1-2000th, min. 1-8000th),—in the mouse, 1-3814th,—in the ass, 1-4000th—(rabbit, 1-4000th),—in the pig, 1-4230th (1-4250th)—in the ox, 1-4267th,—(in the cow, 1-4000th to 1-4200),—in the cat, 1-4400,—in the horse, 1,4600 (1-5000th), in the sheep, 1-5300th (1-5333rd to 1-6000th), —in the goat, 1-6366th. These measurements apply to *recent* blood, which has not been allowed to become dry on animal and vegetable stuffs. In this case a distinction might be made between the blood of a human being and a sheep or goat. With respect to the dog, hare, and rabbit it would be, even under these favourable circumstances, a matter of some difficulty. When blood is dried on clothing, and it is necessary to extract the corpuscles by means of a liquid of a different nature from the serum, we cannot rely on slight fractional differences, since we cannot be sure that the corpuscles, after having been once dried, will ever reacquire in a foreign liquid the exact size which they had in serum. Medical evidence must therefore be based, in such cases, on mere speculation. (See 'Guy's Hospital Reports,' vol. 7, pt. 2, 1851.)

The subjoined illustrations represent, in the dry state, the blood-corpuscles of twelve animals—ten taken from the mammalia or warm-blooded sucking animals—one from a bird, and one from a reptile. All are represented under the same magnifying power in quadrants of circles, so as to allow of a comparison.

On comparing the ten samples of mammalian blood in these illustrations, with that representing human blood (in fig. 114, 115, p. 545) prepared under precisely similar circumstances and magnified in the same degree, it will be per-

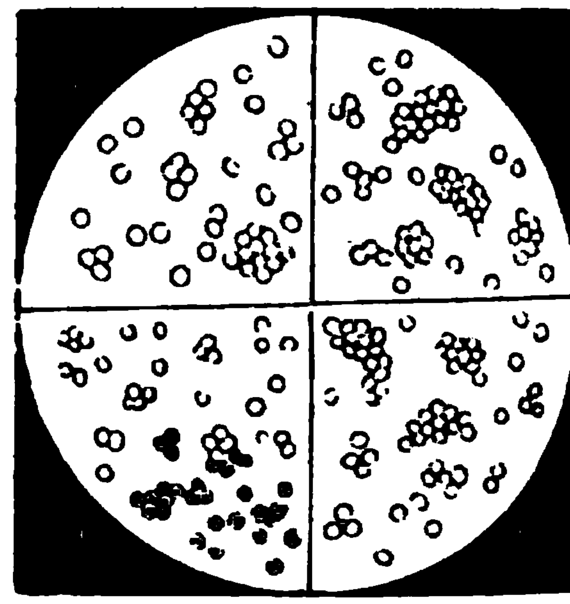
ceived that the only difference consists in the human corpuscles being somewhat larger. The difference in size, however, from the corpuscles of the dog and the rabbit is so small as to be scarcely appreciable. The corpuscles of

Fig. 118.



Blood-corpuscles, magnified 319 diameters.
a. Of the dog. b. Of the mouse.
c. Of the rabbit. d. Of the ass.

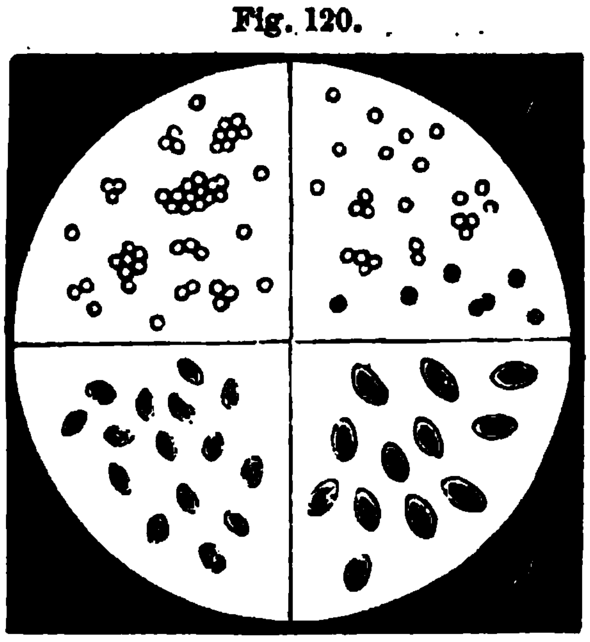
Fig. 119.



Blood-corpuscles, magnified 319 diameters.
a. Of the cow. b. Of the pig.
c. Of the ox. d. Of the cat.

the bird and the reptile are well characterized by their size, the oval shape, and the presence of a nucleus in the centre of each. The length of the corpuscle of the fowl's blood, was found by measurement to be the 1-2250th part of an inch, and its width the 1-4500th of an inch. The length of the corpuscles in the salamander was the 1-750th of an inch, and the width the 1-1125th of an inch. In reference to the scientific question proposed, it must be regarded as still unsolved. There are no certain methods of distinguishing, microscopically or chemically, the blood of a human being from that of an animal, when it has been once dried on an article of clothing.

Fig. 120.



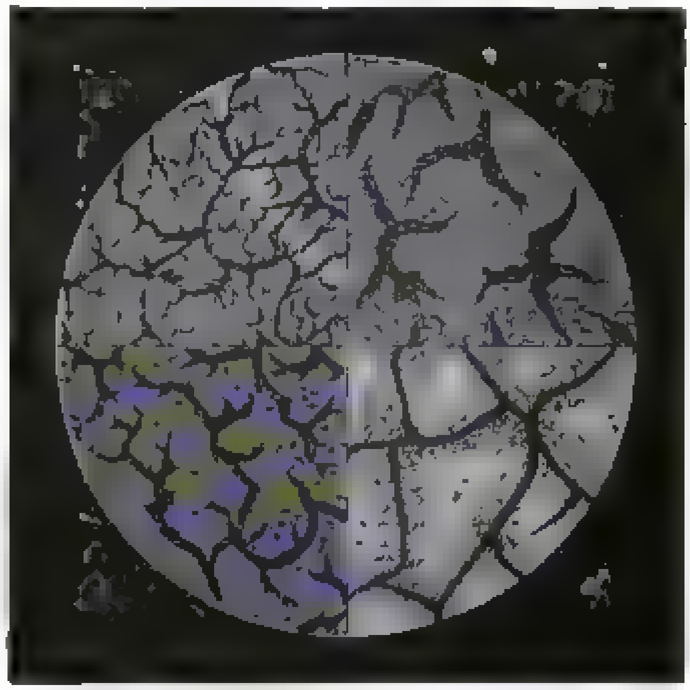
Blood-corpuscles magnified 319 diameters.
a. Of the horse.
b. Of the sheep.
c. Of the common fowl.
d. Of the salamander.

The extent to which a medical witness is justified in going on trials for murder, on which this important question frequently arises, appears to me to be this: the size and shape of the corpuscles are or are not consistent with their being the corpuscles of human blood; but it is impossible, in the present state of science, to affirm that the corpuscles extracted from stains dried on clothing or weapons are not those of some domestic animal belonging to the class mammalia. This was the substance of the evidence which I gave in the case of *Reg.* v. *Munro* (Cumberland Lent Assizes, 1855)—a case in which everything turned on circumstantial evidence of a medical and moral kind. I declined to say absolutely that the stains were caused by human blood, although the corpuscles coincided in measurement with them. In one instance a medical witness professed to make a distinction between certain spots on a man's clothes—assigning some to the blood of a horse, and others to human blood; and on another occasion scientific evidence was so strained by a witness upon this question as to elicit a sharp rebuke from the learned judge who tried the case. (*Reg.* v. *Nation*, Taunton Spring Assizes, 1857, see p. 279; also 'Med. Times and Gazette,' April 11, 1857, p. 365.) For information on this subject, see Ritter's Prize Essay, 'Ueber die Ermittelung der Blutflecken in Kriminalfällen,' Wurzberg, 1854, and Friedberg's 'Histologie des Blutes,' Berlin, 1852. These authors affirm, from their observations, that it is not possible to distinguish by the microscope human from animal blood

s criminal cases. Evidence based upon such varying averages as those above iven must be treated as speculative and unsafe.

A novel method of distinguishing human from animal blood has been prooсed by Neumann ('Die Erkennung des Blutes bei gerichtlichen Untersuchungen,' Leipzig, 1869). A solution of the red colouring matter, procured s already described (p. 530), is ently evaporated on a glass slide t a temperature of about 60°. In his way a reddish-coloured film obtained, which in drying breaks p into various forms, differing, t is said, in the blood of man and nimals. Twenty-three coloured ictures are given by the author, howing the differences in the apearances presented by the blood f man and animals thus treated. The annexed engraving (fig. 121) hows four different forms or pictures of the dried films of blood, with the cracks, as they were een by Dr. Neumann. The quadant *a* represents human blood, the blood of the dog, *c* the blood f the sheep, and *d* the blood of he pig. In some experiments n the subject I have not found hat the blood in drying, assumes for the same animal the same form, and that he result depends on the thickness of the film, the temperature of evaporation, nd a variety of conditions which render the process uncertain. In three patches f human blood on the same slide the cracks assumed different shapes; and the lood of an animal thus treated presented one form or picture in the centre and different form at the circumference. A reliance on such accidental differences would give rise to continual mistakes.

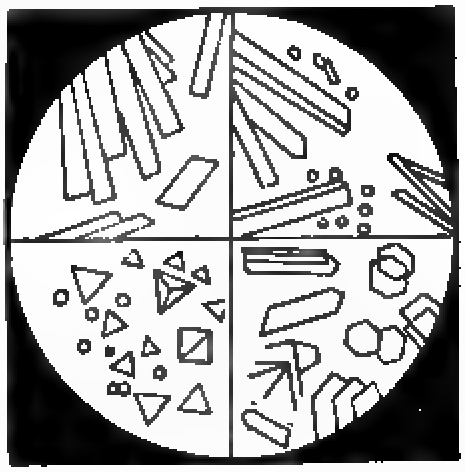
Fig. 121.



Appearances presented by films of dried blood in man (*a*), the dog (*b*), the sheep (*c*), and the pig (*d*).

Blood-crystals. Hæmatin.—Another process for the microscopical detection of blood has been of late years employed by some German medical jurists. It onsists in procuring crystals from the dry red colouring matter of blood. Lehmann and Kunze ascertained that all red blood is capable of crystallization or of breaking up into crystalline forms, from whatever animal or organ t may have been taken. Lehmann thus describes his method of procuring hese hæmatin crystals. A drop of blood which has been kept a day is allowed to evaporate on a glass slide; a drop of distilled water is then added, and the whole is covered with a slip of thin glass. After a time, when the water has to some extent evaporated, regular red-coloured crystals, of various sizes and forms, such as those represented in the quadrant *a* of fig. 122, are visible. Some are columnar and prismatic, while others are in the form of rhombic plates. The second quadrant, *b*, represents the crystals procured, by a similar process, from the heart-blood of a cat. The third, *c*, crystals from the venous blood of a guinea-pig, which appear in regular tetrahedra; and the fourth, *d*, crystals from the venous blood of a squirrel; some of which are prismatic, and others in the form of rhombic and hexahedral plates.

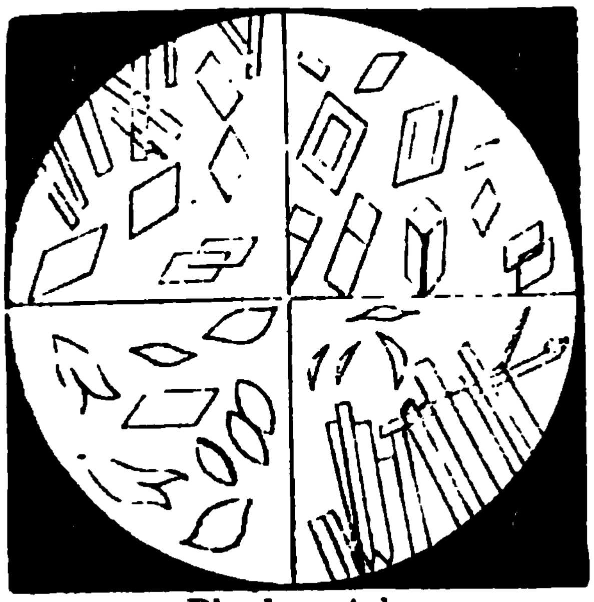
Fig. 122.



Hæmatin crystals.

The hæmatin crystals are represented in this and the other engravings as transparent. They are, in fact, translucent, and under a good light, of a well-marked red or red-brown colour.

Fig. 123.

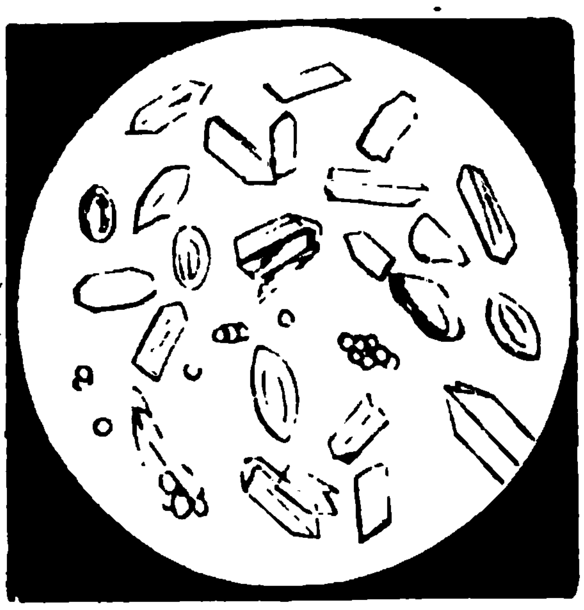


Blood-crystals.

In fig. 123 the first quadrant, *a*, shows the prisms and rhombic plates obtained by Lehmann from human venous blood; *b*, blood-crystals from human blood in rhombic plates, as delineated by Robin and Verdeil ('Chimie Anatomique'), and *c*, crystals obtained from human blood, by Dr. Kunze, by a process described below. Some of these have a rhombic form; others are shaped like a hemp-seed; and a few, being double at one extremity, have the appearance of a swallow's tail. In the quadrant *d* are represented crystals as obtained by Lehmann from the red blood of a fish. It is to be observed of these crystals that they are all coloured, having more or less the red colour of the blood.

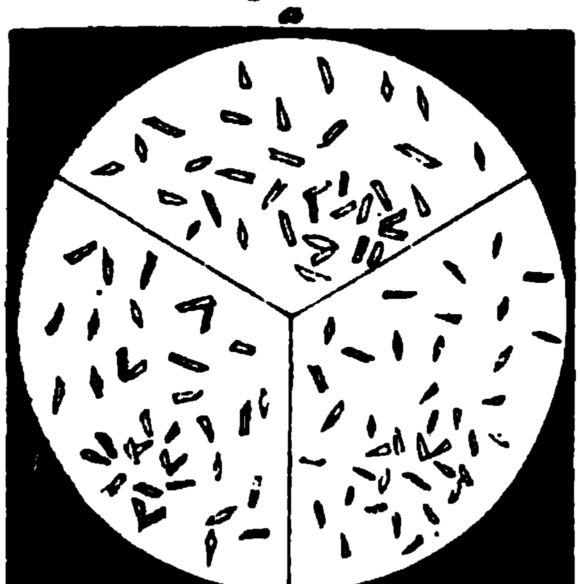
In applying Lehmann's process to a fragment of a dried clot of human blood, which had been kept for six months, prismatic crystals were seen, mixed with bodies of an ovoid shape. A number of these are delineated in the next engraving (fig. 124). They have the characters of the phosphates and other salts of the blood. No rhombic plates, or tetrahedra, such as those described by Lehmann, were seen. The prismatic crystals had the characters of phosphate of magnesia. They were colourless on a red ground, which owed its colour to the dissolved hæmatin.

Fig. 124.



The production of crystals from the colouring matter of blood, as contained in a dry coagulum, may be easily effected by a process suggested by Dr. Kunze, of Merseburg. (Casper's 'Vierteljahrsschrift,' April 1864, p. 262.) This gentleman recommends the strongest glacial acetic acid. As the object is not here to search for blood-corpuscles, any stuff superficially stained is soaked in a small quantity of water for one or two hours, until the colouring matter is dissolved, and a reddish-brown solution is obtained. The red liquid is evaporated to dryness, and the dry residue is boiled in an excess of glacial acetic acid, until the acid is strongly coloured. The acid liquid is poured off, and one or two particles of common salt are well stirred into it. It is then slowly evaporated on a slide, or on a watch-glass, at a temperature of about 180°, and the residue is examined, either in the wet or dry state, by a microscopical power of 300 to 500 diameters. The blood-crystals, if present, appear in groups, as small dark specks. They are somewhat irregular in shape—have generally a prismatic form, some with rhombic terminations, while others assume a spindle shape, and others again are joined at an angle, so as to resemble a bird's tail, or they cross each other like the letter X. Kunze describes them of the form delineated in fig. 123 *c*. In repeating Kunze's experiments, I have

Fig. 125.



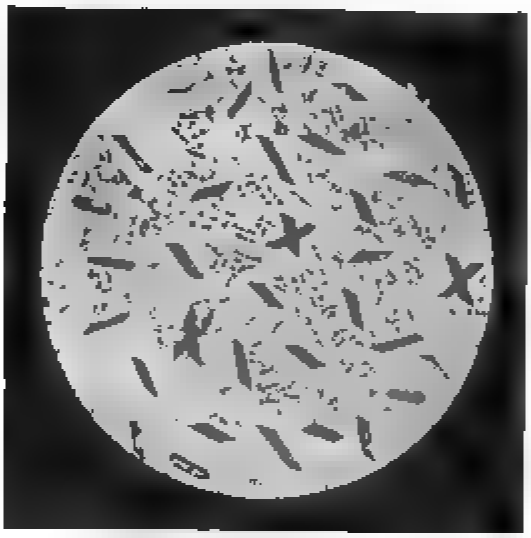
Hæmatin or blood-crystals, magnified 517 diameters.

found that the use of common salt was not necessary. It had the effect of encumbering the field of view with cubic and other crystals of chloride of sodium. Having removed a portion of the dried coagulum from human blood, which had been kept loosely exposed for six months, I powdered it and boiled it in glacial acetic acid, in a small porcelain cup, until a quantity of colouring matter had obviously been dissolved. The acetic acid, under these circumstances, acquired a dark reddish or reddish-brown colour. A few drops of the clear liquid, evaporated on a slide, left minute red-coloured crystalline-looking masses, like those seen in *a*, fig. 125. They were plainly distinguishable from the cubic crystals of common salt, naturally contained in the blood, as well as from the phosphates. They varied much in size and shape, but generally assumed the form of slender prisms with irregular rhombic terminations. *Hæmatin crystals*, as they were thus procured from human blood, were found to have an average length of 1-2250th of an inch and a width of 1-9000th of an inch. Those obtained from sheep's blood were smaller than those obtained from the blood of man and of the bullock. A fragment of the dried blood of the bullock, which had been on a rag for about six years, gave, when similarly treated, the group of red-coloured crystals seen in *b*; and blood of the sheep, of old date, gave the form seen in *c*. The crystals in the latter are smaller than those produced from human and bullocks' blood, but the resemblance is so great, that it would be obviously impossible to base any distinction between human and animal blood upon these observations.

Blondlot recommends as a solvent for obtaining the crystals, alcohol mixed with one-twentieth part of ammonia. (Ann. d'Hyg. 1868, 1, 140.)

Dr. Falk advises for the separation of blood from stained clothing the employment of iodide of potassium in the proportion of one part to four parts of water. The red colouring matter is extracted by the iodide more readily than by water. (Horn's 'Vierteljahrsschrift,' 1867, 1, 354.) The red liquid is mixed with glacial acetic acid, and then evaporated to crystallization. Dr. Ivan Gwosdew, of Moscow, who attended the lectures on Medical Jurisprudence at Guy's Hospital in 1869, adopts another method, which embraces the use of the spectroscope, as well as the production of crystals. The dry clot is treated with alcohol and carbonate of potash. The red colour is extracted, and this gives a single band in the spectroscope between C and D on the spectrum. The colouring matter is thrown down by dilution with water and the addition of acetic acid. To procure crystals the precipitate is dried, mixed with common salt and glacial acetic acid, and evaporated at 212°. ('Ueber die Darstellung der Hämin,' 1866.) A perfect specimen of these crystals has been handed to me by Dr. Gwosdew. They are quite insoluble in water, yet when treated with an alcoholic solution of guaiacum and peroxide of hydrogen they acquire the blue colouration of blood. By Dr. Gwosdew's method three distinct processes for the detection of blood, may be thus applied to the colouring matter extracted from a small stain. The colouring matter of blood so treated may be converted into quasi-crystalline forms, still preserving its red colour; and microscopical evidence of blood may be thus obtained, in cases in which the blood-corpuscles have not been successfully extracted by liquids. A very small quantity of dry coagulum will suffice to yield this corroborative evidence. An additional branch of research

Fig. 126.



Blood-crystals, as obtained from human blood (Neumann).

is thereby opened to a medical jurist. The association of cubic crystals of salt with these blood-crystals, when no chloride of sodium has been added to the liquid, is an additional proof of the presence of blood, as this is one of the principal saline constituents of that fluid. In stains of old date I have observed, in association with hæmatin crystals, dagger crystals, resembling those of hydrochlorate of ammonia. Similar experiments were made with the colouring matters of cochineal, logwood, and kino. On treating the first with acetic acid, a pink-red colour, differing from that of blood, is produced, while the extracts of logwood and kino give a yellowish-brown colour with this acid. In no case, on evaporating the acid solutions, were any crystals resembling those of hæmatin cr chloride of sodium obtained.

For further information on the subject of blood-stains, I must refer the reader to the following works: 'Blutkrystalle Untersuchungen,' von W. Preyer, Jena, 1871; Neumann, 'Erkennung des Blutes,' Leipzig, 1869; 'Ann. d'Hyg.' 1865, 1, 139; 1868, 1, 130; 1870, 2, 432; Henke's 'Zeitschrift der S. A.' 1844, b. 2, p. 273; 'Guy's Hosp. Reports,' Oct. 1851; 1867, p. 432; 1870, p. 274; Casper's 'Vierteljahrsschrift,' 1862, vol. 1, pp. 15, 250, 256; 1863, vol. 2, p. 193; 1867, 1, 354, and 'Chemical News,' 1868, p. 124.

CHAPTER 39.

IMPUTED OR SELF-INFLICTED WOUNDS—MOTIVES FOR THEIR PRODUCTION—MEDICO-LEGAL INVESTIGATION OF THESE CASES.

Imputed or self-inflicted Wounds.—The question whether a wound was or was not self-inflicted, may refer to the living as well as to the dead. Thus, a man may produce wounds upon himself for the purpose of simulating a homicidal assault, which, for various motives, he may allege to have been committed upon him. With the motives for the self-infliction of wounds, a medical jurist is not concerned—it is of the fact only that he can take cognizance. From the cases that have yet occurred, it would appear that the object had been to extort money, to conceal murder, robbery, or some other crime, and to turn away a suspicion of criminality from the wounded person. One of the most remarkable cases of this kind which have occurred in England, was that of *Bolam*, who was tried for the murder of a man named Millie, at the Newcastle Autumn Assizes, 1839. It is impossible to enter into all the particulars of this singular trial; but it may suffice to state that the prisoner Bolam was found lying in an apartment which had been fired by himself, or, as he alleged, by some incendiary, and near him was the body of the deceased, who had evidently been killed by violence—the skull having been extensively fractured by a poker lying near. The prisoner, when found, was either insensible or pretended to be so. He stated that he had been suddenly attacked by a man and knocked down by a blow on the right temple. After attempting to escape, he was again knocked down. He then felt a knife at his throat, but admitted that he did not put up his hands to protect it. His hands were not cut. He said he remembered receiving some blows on his body, but he became insensible, and recollected nothing more. On examining his throat, there was a wound an inch and a half in length on the left side of the neck, a quarter of an inch below the jaw. It had penetrated nearly through the true skin, and was of inconsiderable extent. A small quantity of blood, which had flowed down on the inside of his cravat, had escaped from this wound.

There were many cuts on his coat at the back and sides, through his waistcoat, shirt, and flannel-shirt; but there were no corresponding cuts or stabs, nor, indeed, any mark of injury upon the skin. The question was whether these wounds were inflicted by the unknown person, who was alleged to have fired the premises and murdered the deceased, or whether the prisoner had inflicted them on himself, in order to divert attention, and conceal the crime which he was accused of having commited. No motive for the imputed crime was discovered, and he had borne a very good character: but, nevertheless, the medical facts relative to the self-infliction of wounds were so strong, that he was convicted of manslaughter. There was no doubt that the prisoner had produced the wounds upon himself in order to remove the suspicion that he had caused the death of the deceased. They were superficial, involved no important organs, and bore the characters which those wounds only would have, which had not been produced with a suicidal intention.

Soon after Bolam's case, one somewhat similar occurred in London. The steward of a club-house was found one morning in bed wounded, and the cash-box of the club was missing. Circumstances led the police to suspect that no one could have broken into the house; but the man himself was considered so trustworthy, that no suspicion was entertained of his having been concerned in the robbery. The late Mr. B. Cooper, who examined him, found the wounds on his person of a trivial character; and there was no doubt, from what subsequently transpired, that he had produced them on himself, for the purpose of averting suspicion.

It is not always easy to trace a motive for the production of these injuries; and when a reasonable motive is not immediately discovered, persons are apt to be misled and to credit the story. Individuals who have been convicted of thus imputing violence to others, have frequently borne a respectable character until the occurrence, and this has contributed to give support to their statements. When a person intending to commit suicide fails in the attempt, he has sometimes, under a sense of shame, attributed the infliction of a wound in his throat to another; but facts of this kind may without difficulty be cleared up by circumstantial evidence. Imputed wounds, if we except the case of an actual attempt at suicide, in which the injury is commonly severe, are generally of a *superficial* character, consisting of cuts or incisions not extending below the true skin; deep stabs are seldom resorted to where the purpose is not suicide but merely to conceal other crimes. Further, these wounds are in *front* of the person, and may be on the right or left side, according to whether the person is right or left-handed. They have also been generally *numerous*, and widely scattered; sometimes they have had a complete parallelism, unlike those which must have been inflicted by an adversary during a mortal conflict with a weapon. The *hands* are seldom wounded, although in the resistance to real homicidal attempts, these parts commonly suffer most severely. The injuries are not usually situated over those parts of the body in which wounds are by common repute considered *mortal*, and there is in general an entire want of correspondence between the situation of the wounds on the person, and the cuts or other marks on the *dress*; or the cuts in the dress are not reconcilable with the articles of dress having been worn when they were produced. Facts of this kind require special attention. In a case which occurred to Dr. Marc, a young man alleged that he had received a sword-cut on the forehead from some assailants who had escaped. He was allowed to relate the whole of the particulars, and they formed a romantic and improbable story. He stated that he wore at the time a handkerchief round his head, a cotton cap, and a common cap with an elastic front, which he alleged had been cut through. There was a longitudinal wound, quite superficial and about an inch long, at the upper and right part of the frontal bone,

passing downwards from *left to right*. The cut in the felt of the cap, which was very soft, passed obliquely from *right to left*, and was about three inches in length. The cut was not so clean or regular as if it had been produced by a sword; there was very little blood upon the cap, and only on the edge of the incision. The silk handherchief was cut in an irrregular manner. When the person was requested to place the cap and other articles upon his head in the position in which he stated they were when he was attacked, it was found to be utterly impossible to adjust them so as to make the incisions correspond, and the cap could not be worn over the folded handkerchief. This rendered it certain that the wound had not been inflicted in the manner described. Besides, a blow of a sword which would have divided the felt and silk handkerchief, would at the same time have produced a much deeper wound on the forehead than that which was found. In a case reported by Dr. Bayard, the falsehood of a similar charge was demonstrated by the want of correspondence between the cuts in the clothes and those found on the person. ('Ann. d'Hyg.' 1847, 2, 222. See also 'Case of Wiggins,' p. 492.) In comparing cuts on the *dress* with wounds on the person, there are several circumstances to be attended to. What articles of dress were worn at the time of the assault? In a case of stabbing all ought to present marks of perforation, corresponding in direction, form, size, sharpness of the edges of the weapon, &c. In imputed wounds the marks on several layers of dress may not correspond with each other in the characters above mentioned. It is very difficult for a man simulating such injuries so to arrange his clothes when off his person, as to deceive a careful examiner. There will be some inconsistency or want of adjustment. Apart from the fact that several stabs or cuts cannot exist on the same part of the clothes, without one or more being stained with blood on the outside or inside, an impostor may either do too much or too little, and thus lead to his detection. (Case of *Wiggins*, p. 492.) In a case of alleged arson to defraud a fire insurance company, which excited much public discussion in London many years since, a simple circumstance led to the inference that certain stabs or cuts through a shirt had not been produced while the shirt was on, but while it was off the body. There were two cuts in the shirt near to each other, precisely similar in size, form, and direction; in fact, the knife or dagger producing them must have gone through a fold of the shirt to produce them, so accurate was the correspondence. Then, however, it followed that the shirt could not have been upon the body of the wounded person as he alleged, because a stab through a shirt when worn over the skin must, in order to reach the body, traverse not only a fold (producing two cuts), but another layer in contact with the skin, and thus produce *three cuts*, or in the event of traversing two folds, *five cuts*. In simulating the wounds by cuts on the shirt, the person is supposed to have forgotten this, and have merely stabbed a fold of the shirt while lying on a table, or in some situation convenient for the purpose. This, among other facts, rendered it probable that the slight wounds on the chest were self-inflicted. A case occurred at Nottingham in February 1872, which shows how persons who inflict wounds and at the same time cut the dress covering the wounded part, may furnish evidence against themselves. A youth charged a man with unlawfully wounding him on the highway. He stated that the man had stabbed him in the arm, cutting through his shirt and coat-sleeve. There was no attempt at robbery, and no motive for such an act. On examining the coat and shirt-sleeve, it was found that they had been cut, but there was no corresponding cut in the lining of the coat-sleeve. The prosecutor could give no explanation of this. It was clear that the charge was false, that there had been no cutting or stabbing by another, but that the wound was self-inflicted, when the coat was not worn. The youth wished to leave the place to which he had been sent by his friends for private study.

It has been contended that no rules can be laid down for the detection of such cases; each must be decided by the facts which accompany it. Nevertheless, the details of those above mentioned will serve to direct the inquiries of a practitioner. The facts which he must endeavour to ascertain are the following:—1. The relative positions of the assailant and the assailed person at the time of the alleged attack. 2. The situation, direction, and depth of the wound or wounds. 3. The situation or direction of marks of blood or wounds on the person or dress of either, or of both the assailant and assailed. 4. The marks of blood, and the quantity effused at the spot where the mortal struggle is alleged to have taken place. The importance of these inquiries cannot be over-estimated. A strong suspicion was raised against the late Duke of Cumberland, in the year 1810, in reference to the death of *Sellis*, when a proper examination of the wounds on the deceased would have shown that they might have been self-inflicted.

It is worthy of remark, that imputed wounds are generally *cuts* or *stabs*. They are seldom of the contused kind: the impostor cannot, in reference to contusions, so easily calculate upon the amount of mischief which is likely to ensue. Dr. Bergeret, however, has related some cases in which females labouring under hysterical attacks have inflicted upon themselves severe contusions, and have charged innocent persons with attempts to murder. ('Ann. d'Hyg.' 1863, 1, 463.) In general the inconsistency of the story is so palpable as to betray the imposture at once; but the public are easily deceived, and much prejudice is often unjustly excited on these occasions against those who have been falsely accused. Slight excoriations or bruises may be magnified into marks of murderous violence, and if a medical man can be found to admit in an unqualified form that a severe blow can be inflicted and yet leave but slight marks on the skin, the charge will be considered proved against the unfortunate accused. The case of *M. Armand*, a merchant of Montpellier, who was tried at the Assizes at Aix, in March 1864, for an alleged murderous assault upon his servant Maurice Roux, furnishes a good illustration of the readiness with which the most inconsistent stories are accepted by the public when they are supported by pseudo-medical evidence. This case was rather one of imputed homicidal strangulation than imputed wounding; nevertheless a foundation was laid for medical opinions by the presence, as it was alleged, of a slight excoriation of the skin on the nape of the neck. The injury was so slight that it escaped the observation of some medical men who examined the complainant, and there could be no doubt from the facts that it had been produced either accidentally or designedly by the complainant on himself. Several medical gentlemen, taking the man's story as true, asserted without any qualification, 1. That a blow on the nape of the neck might produce cerebral concussion and syncope. 2. That a blow to produce such effects need not be violent; and 3. That such a blow so inflicted would not always leave upon the skin marks of contusion or ecchymosis. These admissions were taken by the Court to support the man's story—that his master struck a severe blow on the back of his neck, and this had produced concussion of the brain, and that he had been rendered insensible for many hours. ('Ann. d'Hyg.' 1864, 1, 451.) The evidence for the defence, and chiefly that given by M. Tardieu, removed the evil effect produced by such loose medical answers as these, and satisfied the jury that the statement of the complainant was a pure fabrication. The accused was justly acquitted of the charge. Although it has been elsewhere stated that severe blows are not always attended with external marks of violence (p. 468), it by no means follows that such blows have been struck in all cases in which the skin presents a slight abrasion. This would be converting the exception into the rule, and every superficial injury might be thus distorted into a proof of the infliction of murderous violence.

Pistol-shot wounds are sometimes voluntarily inflicted for the purpose of imputing murder or extorting charity. A man intending to commit suicide by fire-arms, and failing in the attempt, may also from shame or a desire to conceal his act, attribute the wound to the hand of an assassin. In examining such imputed wounds they will not be found to involve vital parts, except in cases of attempted suicide, and they will possess all the characters of near-wounds produced by gunpowder, wadding, or a bullet. (See GUN-SHOT WOUNDS.) The skin around will be more or less lacerated and bruised; there will be much ecchymosis, and the hand holding the weapon, as well as the dress and the wounded skin, may be blackened or burnt by the exploded gunpowder. A pistol-shot wound from an assassin may be produced from a distance, while an imputed wound which is produced by a person on himself must always partake of the characters of a near-wound. If the weapon has been charged with gun-cotton, there will be no marks of blackening on the person or dress, but there may be marks of burning.

CHAPTER 40.

THE CAUSE OF DEATH IN WOUNDS—CAUTION ON ASSIGNING TOO MANY CAUSES—WOUNDS DIRECTLY OR INDIRECTLY FATAL—DEATH FROM HÆMORRHAGE—LOSS OF BLOOD REQUIRED TO PROVE FATAL—MODIFIED BY AGE AND OTHER CIRCUMSTANCES—FATAL WOUNDS OF SMALL ARTERIES—INTERNAL HÆMORRHAGE—DEATH FROM MECHANICAL INJURY TO A VITAL ORGAN—DEATH FROM SHOCK—BLOWS ON THE ABDOMEN—FLAGELLATION—DEATH FROM NUMEROUS INJURIES WITHOUT ANY MORTAL WOUND.

Cause of death.—It is important for a medical witness to bear in mind that in all cases of wounds criminally inflicted, the cause of death must be *certain*. No man is ever convicted upon mere medical probability. In general, there is only *one* real cause of death, although other circumstances may have assisted in bringing about a fatal result. Thus, a person cannot die of disease in the bowels and a stab in the chest at the same time, nor of apoplexy from disease and compression of the spinal marrow at the same instant. Hence it is our duty, when several apparent causes for death exist, to determine which was the *real* cause; and in stating it to the Court, to be prepared to offer our reasons for this opinion. In most cases of local injury, when a person dies speedily, there will be no great trouble in settling whether disease or the wound was the cause. A difficulty may, however, exist when a person has recovered from the first effects of a wound, and has subsequently died. Besides, there may be cases in which the cause of death, in spite of the most careful deliberation, will be still obscure; or sometimes it may happen that the death of a person appears to be as much dependent on bodily disease as on an injury proved to have been received at the time he was labouring under disease. How is an opinion to be expressed in such a case? The course which I apprehend a medical witness ought to pursue, provided he has duly deliberated on the circumstances before he appears in court, and his mind is equally balanced between the two causes, is to state at once his doubt to the jury without circumlocution, and not allow it to be extracted from him in cross-examination. It is the hesitating to assign a satisfactory cause, or the assigning of many causes for death, that gives such advantage to a prisoner's case, even when the

general evidence is entirely against him. Occasionally many causes of death are assigned by a witness, among which some have a tendency to exculpate and others to inculpate the prisoner in a greater or less degree, and it is left to the jury to select from the number one upon which to found a verdict! In a case of this kind an acquittal is commonly directed.

Wounds directly or indirectly fatal.—A wound may cause death either *directly* or *indirectly*. A wound operates as a *direct cause of death* when the wounded person dies either immediately, or very soon after its infliction; and there is no other cause, internally or externally, to account for death. In wounds which cause death *indirectly*, it is assumed that the deceased survives for a certain period, and that the wound is followed by inflammation, suppuration, pyæmia, gangrene, tetanus, erysipelas, or some other mortal disease, which is a direct, and not an unusual consequence of the injury. Under this head may be also arranged all those cases which prove fatal by reason of surgical operations rendered imperatively necessary for the treatment of injuries —presuming that these operations have been performed with ordinary skill and care. We shall for the present consider only the direct causes of death in cases of wounds. They are three in number:—1. *Hæmorrhage*, or loss of blood. 2. *Great mechanical injury* done to an organ important to life. 3. *Shock*, or concussion, affecting the brain or spinal marrow, whereby the functions of one or more vital organs are arrested, sometimes with but slight injury to the part struck or wounded. From either of these causes, a wounded person may die immediately or within a few minutes.

1. *Death from hæmorrhage* —Loss of blood operates by producing fatal syncope (p. 162). A quantity of blood escaping from a vessel, although insufficient to cause death by affecting the heart and circulation, may readily destroy life by disturbing the functions of the organ or part into which it is effused. Thus, a small quantity effused in or upon the substance of the brain, or at its base, may prove fatal by inducing fatal compression; and again, if, in a case of wounded throat, blood should flow into the windpipe, it may cause death by asphyxia—*i.e.* by stopping the respiratory process (p. 163). In these cases it is obvious that the blood acts mechanically; and in respect to the last condition a medical man, unless circumspection is used, may involve himself in a charge of malapraxis. If he allows the wound to remain open, the wounded person may die through hæmorrhage—if he closes it too soon, he may die through suffocation; and, in either case, the counsel for a prisoner will not fail to take advantage of a plausible objection of this kind. In wounds of the chest, involving the heart and lungs, death is frequently due not so much to the actual quantity of blood effused, as to the pressure which it produces upon these organs. A few ounces effused in the cavity of the membrane including the heart (pericardium), will entirely arrest the action of this organ.

The absolute *quantity of blood* required to be lost in order to prove fatal, will, of course, vary according to numerous circumstances. The young, the aged, they who are labouring under infirmity or disease, will perish sooner from loss of blood than others who are healthy and vigorous. Females, cæteris paribus, are more speedily destroyed by bleeding than males. Infants are liable to die from this cause, as a result of slight wounds. An infant has been known to bleed to death from the bite of a single leech, or from the simple operation of lancing the gums. Even the healthy and vigorous, when their vital powers have been depressed by maltreatment or by brutal violence, will sink under the loss of a comparatively small quantity of blood. (See 'Watson on Homicide,' p. 90.) A medical jurist must not forget that some persons have a predisposition to excessive bleeding from slight injuries; and this condition is often hereditary. The slightest wound or puncture—the bite of a leech or the extraction of a tooth—will be attended with a loss of blood which cannot

be arrested, and which will slowly lead to death by exhaustion. Cases have been frequently recorded in our medical journals of fatal hæmorrhage following the extraction of teeth, when there had been previously nothing to indicate the probable occurrence of death from so trivial a cause. (For striking instances of this remarkable tendency to hæmorrhage in a family, see 'Brit. and For. Med. Rev.' vol. 17, p. 247; also, 'Med. Gaz.' May 1842.) In the thirty-ninth volume of the latter journal, p. 86, a case is reported by Dr. Druitt, in which an unusual degree of bleeding followed a compound fracture of the leg. Such cases are without difficulty detected; since a surgeon may always infer, from the part injured and the extent of the injury, whether the bleeding is likely to be copious or not. When a person bleeds to death from what would, under common circumstances, be a simple wound, the admission of this fact may in certain cases lessen the responsibility of an accused party.

A *sudden loss* of blood has a much more serious effect than the same quantity lost slowly. A person may fall into a fatal syncope from a quantity of blood lost in a few seconds, which he would have been able to bear without sinking had it escaped slowly. This is the reason why the wound of an artery proves so much more rapidly fatal than that of a vein. Death speedily follows the wound of a large artery like the carotid; but it takes place with equal certainty, although more slowly, from wounds of smaller arteries. In a case in which one of the intercostal arteries was wounded by a small shot, hæmorrhage caused death in thirty-eight hours. The loss of blood which follows the division of the smaller branches of the external carotid artery, is often sufficient to destroy life, unless timely assistance be rendered. A case was tried at the Berkshire Spring Assizes, 1832, in which it was proved that the prisoner had killed his wife by stabbing her in the leg; a small artery (the anterior tibial) was divided, and the woman died from hæmorrhage half an hour afterwards. Wounds of arteries, even smaller than these, might in some subjects prove fatal, if no assistance were at hand. Mr. Watson mentions a case in which the internal mammary artery on the left side was divided by a stab in the chest. The woman died on the ninth day, and four pounds of blood were found effused on that side. In another case in which an intercostal artery was divided, six pounds of blood were effused. (Op. cit. 101.) In both cases, as in most wounds of the chest, the blood not only affected the system by its loss, but by its compressing the lungs and impeding respiration. Wounds of large veins, such as the jugular, may, from the quantity of blood suddenly lost, speedily destroy life. If a wound is in a vascular part, although no vessel of any importance be divided, the person may die from bleeding. It is difficult to say what quantity of blood should be lost, in order that a wound may prove fatal. The whole quantity contained in the body of an adult is calculated at about one-fifth of its weight—*i.e.* about thirty pounds; of this, one-fourth is considered to be arterial, and the remaining three-fourths are venous blood. Some physiologists have estimated the proportion as one-eighth of the weight of the body. ('Med. Times and Gaz.' Aug. 28, 1858, p. 232.) According to Mr. Watson, the loss of from five to eight pounds is sufficient to prove fatal to adults. But while this may be near the truth, many persons will die from a much smaller quantity; the *rapidity* with which the effusion takes place having a considerable influence. It has been found, by experiment, that a dog cannot bear the loss of more blood than is equivalent to one-twelfth part of the weight of its body.

Internal hæmorrhage.—Hæmorrhage may prove fatal, although the blood does not visibly escape from the body. In incised wounds, the flow externally is commonly abundant; but in contused, punctured, and gun-shot wounds, the effusion may take place internally and rapidly cause death. In severe contusions or contused wounds, involving highly vascular parts, the effusion may go

on to an extent to prove fatal, either in the cavities of the body or throughout the cellular membrane and parts adjacent: many pounds of blood may thus be slowly or rapidly effused. The most fatal internal hæmorrhages are those which follow ruptures of the organs from violence or disease. Ruptures of the heart, lungs, liver, and kidneys, have thus caused death. In November 1864, a man who had been run over was brought to Guy's Hospital. He complained of pain in the back, but there were no symptoms of severe injury, and no marks of violence were seen on the skin of the back. He left the hospital and walked with some assistance to his home. A few hours afterwards he was found dead in bed. On inspection there was a large quantity of blood effused in the abdomen. This had proceeded from one kidney, which had been ruptured transversely through its whole substance. In these cases the hæmorrhage is not immediate. Slight muscular exertion may accelerate it and cause death. In death from severe flagellation, blood may be effused in large quantity beneath the skin and among the muscles; this effusion will operate as fatally as if it had flowed from an open wound.

The means of ascertaining whether a person has died from bleeding by an open wound are these:—Unless the wound is situated in a vascular part we shall find the vessel or vessels from which the blood has issued, divided—the neighbouring vessels empty, and the body more or less pallid; although this last condition is of course liable to be met with in certain cases of disease, as also under copious venesection—points easily determined by an examination. The blood will commonly be found more or less clotted or coagulated on those surfaces on which it has fallen. If, with these signs, there is an absence of disease likely to prove rapidly fatal, and no other probable cause of death is apparent, it may be fairly referred to loss of blood. This opinion may, however, be materially modified in reference to open wounds, by the fact of the body not being seen on the spot where the injury was actually inflicted—by the wound having been sponged—the blood removed by washing, and all traces of bleeding destroyed. Under these circumstances, the case must in a great measure be made out by presumptive proof; and here a medical witness may have the duty thrown upon him of examining articles of dress, furniture, or weapons, for marks or stains of blood.

It must not be supposed that all the blood met with round a wounded dead body, or in a cavity of the body, was actually effused during life. As soon as the heart's action ceases, the arteries pour out no more; but the blood, so long as it remains liquid, *i.e.* from four to eight or ten hours, and the warmth of the body is retained, continues to drain from the divided vessels. The quantity thus lost, however, is not considerable, unless the veins implicated are large, or the part is highly vascular, *i.e.*, full of small vessels. In wounds involving the great vessels of the neck the blood which drains from the wounded part after death may be large.

2. *Death from great mechanical injury done to a vital organ.*—We have instances of this becoming a direct cause of death in the crushing of the heart, lungs, or brain, by any heavy body passing over or falling on the cavities, as in railway accidents. The severe mechanical injury is sometimes accompanied by a considerable effusion of blood, so that the person really dies from hæmorrhage; but in other instances the quantity of blood lost is inconsiderable, and the fatal effects may be referred to shock. Sometimes a slight amount of violence may prove fatal. These are, however, to be regarded as exceptional instances. (See case by Mr. Annan, 'Medical Times and Gazette,' August 1854.)

3. *Death from shock.*—This is sometimes a direct cause of death under the infliction of external violence; and in this case life is destroyed without the injury being to all appearance sufficient to account for so speedily fatal a re-

sult. Mr. Savory has suggested that death from shock is nothing more than death from temporary exhaustion of nerve-force, the result of a violent, sudden, and excessive expenditure of it. ('Lectures on Life and Death,' p. 171.) Whatever theory may be adopted to explain it, there is no medical doubt that a person may die from what is termed shock, without any marks of severe injury being discovered on his body after death. We have examples of this mode of death in accidents from lightning, or from severe burns or scalds, in which the local injury is often far from sufficient to explain the rapidly fatal consequences. As instances of this form of death from violence, may be also cited those cases in which a person has been suddenly killed by a blow upon the upper part of the abdomen or on the pit of the stomach, which is supposed to operate by producing a fatal impression on the nerves and nerve-ganglia of the cardiac plexus. Whether this be or be not the true explanation, it is admitted by experienced surgeons that a person may die from so simple a cause without any mark of a bruise externally, or physical injury internally, to account for death. On the skin there may be some abrasion or slight discolouration; but as it has been elsewhere stated, these are neither constant nor necessary accompaniments of a blow. (An account of the appearances observed in a case of this kind, by Mr. Wood, will be found in the 'Medical Gazette,' vol. 44, p. 218.) Convictions for manslaughter have taken place, when death has been produced under these circumstances. (See 'Travers on Constitutional Irritation,' p. 482; and B. Cooper's 'Lectures on Surgery,' p. 443; Wounds of the Abdomen, *post*; also 'Watson on Homicide,' p. 75.) Concussion of the brain, unattended by visible mechanical injury, furnishes another example of this kind of death. A man receives a severe blow on the head; he falls dead on the spot, or becomes senseless and dies in a few hours. On an inspection, there may be merely the mark of a slight bruise on the scalp; in the brain there may be no rupture of vessels or laceration of substance, and all the other organs of the body are found healthy. In certain railway accidents persons have died under somewhat similar circumstances. There has been no physical indication of a mortal injury, and no cause apparent to account for death. This can be referred only to the shock or violent impression which the nervous system has sustained from the blow or violence—an impression which the vital powers were wholly unable to counteract or resist. A medical witness must give his evidence with caution in such cases; since it is the custom to rely in the defence upon the absence of any visible *mortal* wound or physical injury to account for death, as a proof that no injury was done—a principle which, if once unrestrictedly admitted, would leave a large number of deaths, undoubtedly occurring from violence, wholly unexplained. A trial took place at the Liverpool Autumn Assizes, 1837, wherein several persons were charged with the manslaughter of the deceased, by kicking him behind the right ear. The medical witness deposed that there was in this spot the mark of a severe contusion, but there was no injury whatever to the brain, and the body was otherwise healthy. He very properly ascribed death to the violent shock given to the nervous system, and the Court admitted that the cause of death was satisfactorily made out. The person who inflicted the wound was convicted.

There is another form of shock, which is of some importance in medical jurisprudence. A person may have received *many injuries*, as by blows or stripes, not one of which, taken alone, could, in medical language, be termed mortal; and yet he may die directly from the effects of the violence, either on the spot, or very soon afterwards. In the absence of any large effusion of blood beneath the skin, death is commonly referred to exhaustion, but this is only another mode of expression; the exhaustion is itself dependent on a fatal influence or impression produced on the nervous system. A prize-fighter, after

having, during many rounds, sustained numerous blows on the body, may, either at or after the fight, sink and die exhausted. His body may present marks of bruises, or even lacerated wounds, but there may be no internal changes to account for death. In common language, there is not a single injury which can be termed *mortal*; and yet, supposing him to have had good health previously to the fight, and all marks of disease indicative of sudden death to be absent, it is impossible not to refer his death to the direct effect of the violence. It is a well-ascertained medical fact, that a number of injuries, each comparatively slight, are as capable of operating fatally as any single wound whereby some blood-vessel or organ important to life is directly affected. Age, sex, constitution, and a previous state of health or disease, may accelerate or retard the fatal consequences.

A case of a somewhat similar kind may present itself in the punishment of *flagellation*, which is occasionally followed by death, either as a direct consequence of shock, or from indirect causes, such as inflammation and its consequences. At the trial of *Governor Wall*, the judge directed the jury that the long continuance and severity of pain (in flagellation) may be productive of as fatal consequences as if instruments or weapons of a destructive kind were used. It is not often that scholastic flagellation is a cause of death in this country. One case, however, which occurred a few years since, excited public attention from the atrocity of the circumstances attending it. It was the subject of a trial for manslaughter at the Lewes Autumn Assizes, 1860 (*Reg.* v. *Hopley*). The evidence showed that the prisoner had beaten deceased, a youth of sixteen, most severely for nearly two hours with a rope and stick. The external wounds were slight, but an inspection showed that the muscles as well as all the soft parts beneath the skin had been considerably bruised and lacerated, and that there were extensive effusions of blood in the cellular membrane of the arms and legs. There was no mortal wound in the common sense of the term, but there was no reasonable doubt that the deceased had died from the violence inflicted on him by the prisoner. His guilt was established by the fact that he had endeavoured to conceal the effects of his violence by removing the marks of blood—that he had covered the body of the deceased with clothing so as to conceal the bruises—that he had procured a coroner's inquest to be held in haste, and while concealing from the jury the fact that he had beaten the youth on the night of his death, stated that he had found him dead, and suggested that he might have died of disease of the heart. There can be no doubt, from the medical facts of this case, that the deceased died either while the prisoner was inflicting the violence or soon afterwards. No attempt was made to dispute the cause of death. Apart from the depressing effects on the nervous system of long-continued and severe pain, there was in this instance such an effusion of blood internally as would account for the production of fatal syncope.

On a trial for murder, which took place in Germany, it was proved that the deceased had been attacked with sticks, and that he had been afterwards flogged on the back with willow switches. He died in about an hour. On inspection, there was no mortal wound, nor any injury to a vital organ; there were simply the marks of lacerations and bruises on the skin, apparently not sufficient to account for death; but this was, nevertheless, very properly ascribed to the violence. (Henke, 'Zeitschrift der S. A.' 1836; also 'Brit. and For. Med. Rev.' Jan. 1837, p. 249.) The case of the *Duchess of Praslin*, who was murdered by her husband in Paris, in August 1847, furnishes an additional proof of the fatal effects produced by numerous injuries. On an inspection of the body, it was found that on the head, neck, and both of the hands, there were no fewer than *thirty* distinct wounds, some contused, and others incised and punctured. There were also the marks of many bruises, and the impressions

produced by the nails of the assailant's hand over the mouth. For the most part these injuries were slight, and not one could be said to be necessarily mortal. The most serious wound was situated on the right side of the neck; but even here the carotid artery and internal jugular vein had escaped injury. Death was referred to the loss of blood which had taken place from the numerous wounds inflicted during the struggle with the assassin. ('Ann. d'Hyg.' 1847, 2, 377.) From these considerations, it is obviously absurd to expect that in every case of death from violence or maltreatment, there must be some specific and visible *mortal injury* to account for that event. When the circumstances accompanying death are unknown, a medical opinion should certainly be expressed with caution; but if we are informed that the deceased was in ordinary health and vigour previous to the infliction of the violence, and there is no morbid cause to account for his *sudden* illness and death, there is no reason why we should hesitate in referring death to the effects of a number of injuries. Among non-professional persons an unfounded prejudice exists that no person can die from violence unless there be some distinctly *mortal* wound actually inflicted on the body. By this we are to understand a *visible* mechanical injury to some organ or blood-vessel important to life; but this is obviously an erroneous notion, since death may take place from the disturbance of the functions of an organ important to life without this being necessarily accompanied by a perceptible alteration of structure. The prevalence of this popular error often leads to a severe cross-examination of medical witnesses. Among the questions put, we sometimes find the following:—Would you have said, from the wounds or bruises *alone*, that they were likely to have occasioned death? Now, in answer to this, it may be observed, that we cannot always judge of the probability of death ensuing from the appearance of external violence alone. Because the appearances were slight, it would be wrong to infer that they were *not* sufficient to cause death by shock. Then it may be inquired, Were the wounds or bruises mortal? In the vulgar sense of the word, *i.e.*, by producing great loss of blood, or a destruction of parts, they might not be so; but in a medical view, they may have acted mortally by producing a shock to the nervous system. Again it may be inquired, Which of the several wounds or bruises found on the body of the deceased was mortal? The answer to this question may be, Not one individually, but *all* contributed to occasion death by syncope or exhaustion. It must be remembered, that in cases in which a person has sustained a number of injuries, the loss of a much smaller quantity of blood than in other instances will suffice to destroy life.

It is sometimes a difficult question to decide on the relative degree of mortality of several wounds, and on the share which they have had respectively in causing death. By a wound being of itself *mortal*, we are to understand that it is capable of causing death directly or indirectly, in spite of the best medical assistance. It is presumed that the body is healthy, and that no cause has intervened to bring about or even accelerate a fatal result. The circumstance of a person labouring under disease when wounded in a vital part, will not, of course, throw any doubt upon the fact of such a wound being necessarily mortal, and of its having caused death. If there should be more wounds than one, it is easy to say, from the nature of the parts involved, which was likely to have led to a fatal result. In order to determine, on medical grounds, whether a wound was or was not mortal, we may propose to ourselves this question: Would the deceased have been likely to die at the same time, and under the same circumstances, had he not received the wound? There can obviously be no general rule for determining the mortal nature of wounds. Each case must be judged by the circumstances which attend it. In some continental states, the law requires that a medical witness should draw a distinc-

tion between a wound which is *absolutely* and one which is *conditionally* mortal. An absolutely mortal wound is defined to be that in which the best medical assistance being at hand, being sent for, or actually rendered, the fatal event could not be averted. Wounds of the heart, aorta, and internal carotid arteries are of this nature. A conditionally mortal wound is one in which, had medical assistance been at hand, been sent for, or timely rendered, the patient would, in all probability, have recovered. Wounds of the brachial, radial, and ulnar arteries may be taken as instances. The responsibility of an assailant is made to vary according to the class of injuries to which the wound may be referred by the medical witnesses; and, as it is easy to suppose, there is seldom any agreement on this subject. Our criminal law is entirely free from such subtleties. The *effect* of the wound, and the *intent* with which it was inflicted, are looked to: its anatomical relations, which must depend on pure accident, are never interpreted in the prisoner's favour. Some extenuation may, perhaps, be occasionally admitted when a wound proves mortal through an indirect cause, as inflammation or fever, and medical advice was obtainable, but not obtained until every hope of recovery had disappeared. It appears, however, from the case of the *Queen* v. *Thomas and others* (Gloucester Aut. Ass. 1841), that the mere neglect to call in medical assistance is not allowed in law to be a mitigatory circumstance in the event of death ensuing. The deceased died from the effects of a severe injury to the head, inflicted by the prisoners, but had had no medical assistance. The judge said it was possible that, 'if he had had medical advice, he might not have died; but whoever did a wrongful act must take the whole consequences of it. It never could make any difference whether the party injured had or had not the means or the mind to apply for medical advice.' The prisoners were convicted. According to Lord Hale, if a man be wounded, and the wound, although not in itself mortal, turn to a gangrene or fever for want of proper applications, or from neglect, and the man die of gangrene or fever, this is homicide in the aggressor; for though the fever or gangrene be the immediate cause of death, yet the wound being the cause of the gangrene or fever is held the cause of death, *causa causati*. These nice questions relative to the shades of responsibility for personal injuries, occasionally arise in cases in which persons have been wounded at sea on board of a ship in which there was no surgeon.

CHAPTER 41.

DEATH OF WOUNDED PERSONS FROM NATURAL CAUSES—DISTINCTION BETWEEN REAL AND APPARENT CAUSE—DEATH FROM WOUNDS OR LATENT DISEASE—ACCELERATING CAUSES—WHICH OF TWO WOUNDS CAUSED DEATH?—DEATH FOLLOWING SLIGHT PERSONAL INJURIES.

Death of wounded persons from natural causes.—It is by no means unusual for individuals who have received a wound, or sustained some personal injury, to die from latent natural causes; and as, in the minds of non-professional persons, death may appear to be a direct result of the injury, the case can only be cleared up by the assistance of a medical practitioner. Such a coincidence has been witnessed in many instances of attempted suicide. A man has inflicted a severe wound on himself while labouring under disease; or some morbid change, tending to destroy life, has occurred subsequently to the infliction of a wound, and death has followed. Without a careful examination of the body, it is impossible to refer death to the real cause. The importance of an accurate

discrimination in a case in which wounds or personal injuries have been caused by another, must be obvious on the least reflection. A hasty opinion may involve the accused in a charge of manslaughter; and although a barrister might be able to show on the trial that death was probably attributable not to the wound, but to coexisting disease, yet it must be remembered, that the evidence of a surgeon before a coroner or magistrate, in remote parts of this country, may be the means of causing the person charged, to be imprisoned for some months previously to the trial. This is in itself a punishment, independently of the loss of character to which he must be in the meantime exposed. In 'Guy's Hospital Reports,' October 1850, p. 230, will be found two cases communicated to me by Mr. Procter, of York, in which death from natural causes was wrongly assigned to violence. In a case reported by Dr. Berncastle ('Lancet,' Feb. 15, 1845, p. 185), the deceased, a boy, died from an internal strangulation of the intestine from morbid causes, after wrestling with another boy, who might, but for a careful inspection of the body, have been erroneously charged with having caused his death. (For a similar case, see 'Medical Gazette,' vol. 37, p. 702; also Casper's 'Wochenschrift,' May 24, 1845.)

Death from wounds or latent disease.—A natural cause of death may be lurking within the body at the time that a wound is criminally inflicted, and a close attention to the symptoms preceding and the appearances after death can alone enable a surgeon to distinguish the real cause. A man may be severely wounded, and yet death may take place from rupture of the heart, the bursting of an aneurism, from apoplexy, phthisis, or other morbid causes which it is here unnecessary to specify. ('Cormack's Ed. Jour.' May 1846, p. 343.) If death can be clearly traced to any one of these diseases by an experienced surgeon, the prisoner cannot be charged with manslaughter; for the medical witness may give his opinion that death would have taken place about the same time and under the same circumstances whether the wound had been inflicted or not. The case of *Colonel Gordon*, in April 1854, proves that very slight causes may lead to death, when there is latent disease of the heart or any other important organ. This case was the subject of a trial at the Chester Lent Assizes, 1854 (*Reg.* v. *Sandars*). It appeared from the evidence, that the accused, who was the conductor of a railway train in which deceased was travelling, attempted to eject him from a carriage. The deceased resisted, and in the struggle the prisoner struck him on the left arm. The deceased made no further resistance, but sat quietly in his seat. It was soon afterwards perceived that he was dead. The medical evidence showed that there was ossification of the valves of the heart and aorta, and that this disease had been of long standing. The life of the deceased was at all times in great peril, and his death might have arisen from the excitement which took place previous to the prisoner laying hands upon him. It might have followed in the course of half an hour. As it was thus admitted that excitement alone would account for the fatal result, the prisoner was acquitted. There was no *corporeal* injury done to the deceased which could account for death. In March 1867, a woman, æt. 73, was charged with causing the death of a pauper, by striking her on the cheek. The deceased became insensible, and died in ten minutes. On inspection, it was found that death had been caused by the rupture of an aneurism of the aorta. The medical opinion was that, although the blow was not of itself sufficient to cause death, it had accelerated a fatal result of the disease.

In another case, which was the subject of a trial at the Central Criminal Court, in June 1854 (*Reg.* v. *Champlonier*), appearances sufficient to account for death existed in the part which sustained the violence; but the medical witness could not with certainty refer them to the violence. An old man passing along a road was struck on the forehead with a stone thrown by the prisoner. The surgeon stated that there was a contused wound, and that his nose bled

profusely. The bleeding was arrested, and on the following day he considered the deceased to be out of danger. At a later period of the day, however, the deceased was seized with an apoplectic fit, from which he did not recover. The appearances in the brain were quite sufficient to account for death; but he could not undertake to say that the injury by the stone had in any way produced these appearances. Upon this evidence the supposed connection of the death with the violence was at once set aside as too remote, and the prisoner was discharged.

On these occasions, one of the following questions may arise:—Was the death of the person *accelerated* by the wound, or was the disease under which he was labouring so aggravated by the wound as to produce a more speedily fatal termination? The answer to either of these questions must depend on the circumstances of each case, and the witness's ability to draw a proper conclusion from these circumstances. The maliciously accelerating of the death of another already labouring under disease by an act of unlawful wounding is criminal; for in a legal sense that which accelerates, causes. In *Reg.* v. *Timms* (Oxford Lent Ass. 1870), it was proved that the prisoner had struck deceased some blows on the head with a hatchet. In twelve days, under treatment, he had partly recovered from the effects, but in six weeks afterwards he was seized with inflammation of the brain with convulsions, and died. On inspection, disease of the kidneys was found, of which there had been no symptoms. Death was referred to this disease, and inflammation of the brain as the result of the blows. The learned judge directed the jury, that if they believed the blows conduced in part to the death of the deceased, it was manslaughter, notwithstanding that other causes combined with the blows to account for death. The prisoner was convicted.

Lord Hale, in remarking upon the necessity of proving that the *act* of a prisoner caused the death of a person, says:—'It is necessary that the death should have been occasioned by some corporeal injury done to the party by force, or by poison, or by some mechanical means which occasion death; for although a person may, *in foro conscientiæ*, be as guilty of murder by working on the passions or fears of another, and as certainly occasion death by such means, as if he had used a sword or pistol for the purpose, he is not the object of temporal punishment.' (I. 247.) Several acquittals have taken place of late years, in cases in which the deaths of parties have been occasioned by terror, or dread of impending danger, produced by acts of violence on the part of the prisoners; not, however, giving rise to bodily injury in the deceased. Conformably to Lord Hale's view, the Criminal Law Commissioners, in their report on the subject of homicide, state:—'Art. 1. The law takes no cognizance of homicide unless death result from *bodily injury* occasioned by some act or *unlawful omission*, as contradistinguished from death occasioned by an influence on the mind, or by any disease occasioned from such influence.' 'Art. 2. The terms "unlawful omission" comprehend every case where anyone being under legal obligation to supply food, clothing, or other aid and support, or to do any other act, or make any other provision for the sustentation of life, is guilty of any breach of such duty.' Under the statute (1 Vict. c. 85, s. 2) it appears from the following case that physical injury only is intended. In *Reg.* v. *Grey* (Huntingdon Lent Assizes, 1857), the prisoner was indicted for causing a bodily injury dangerous to life—to wit, a congestion of the lungs and heart, with intent to murder. It appeared that she had exposed her child to cold and wet, and that congestion or inflammation of the lungs was a result of such exposure. Erle, J., held that the statute under which the indictment was laid contemplated the infliction of some wound or visible injury to the person. The woman was found guilty; but in June 1857, the point having been reserved, the conviction was quashed by the Court for Crown Cases

reserved, on the ground that, looking to the other offences provided for in this statute, this case did not come within it. In *Reg.* v. *Percival* (Midland Circuit, March 1857), a man was charged with the manslaughter of deceased by causing his death by fright, *i.e.*, by personating a ghost. The evidence showed that the boy had sustained no physical injury, but he had received a shock from which he did not recover. Wightman, J., held that in his view the case would fall within the definition of manslaughter. Under the 14 and 15 Vict. c. 100, the necessity for tracing death to some *corporeal* injury appears to be practically abolished. According to the fourth section, in any further indictment for murder or manslaughter it shall not be necessary to set forth the *manner* or the *means* by which the death of the deceased was caused.

Which of two wounds caused death.—It is possible that a man may receive *two wounds* on provocation, at different times, and from different persons, and die after receiving the second: in such a case, the course of justice may require that a medical witness should state which wound was the cause of death. Let us take the following illustration:—A man receives during a quarrel a gun-shot wound in the shoulder. He is going on well with a prospect of recovery, when in another quarrel he receives a severe penetrating wound in the chest or abdomen from another person, and after lingering under the effects of these wounds for a longer or shorter period, he dies. If the gun-shot wound was clearly shown to have been the cause of death, the second prisoner could not be convicted of manslaughter: or if the stab were evidently the cause of death, the first prisoner would be acquitted on a similar charge. It might be possible for a surgeon to decide the question summarily, when, for instance, death speedily followed the second wound; and on inspection of the body, the heart or a large vessel is discovered to have been penetrated; or, on the other hand, extensive sloughing, sufficient to account for death, might take place from the gun-shot wound, and on inspection, the stab might be found to be of a slight nature,—not involving any vital parts. In either of these cases, all would depend upon the science, skill, and judgment of the medical practitioner; his evidence would be so important that no correct decision could be arrived at without it; he would be, in fact, called upon substantially to distinguish the guilty from the innocent. On some occasions death may appear to be equally a consequence of either or both of the wounds; in which case, probably both parties would be liable to a charge of manslaughter. (See 'Ann. d'Hyg.' 1835, 2, 432.) The second wound, which is here supposed to have been the act of another, may be inflicted by a wounded person on himself, in an attempt at suicide, or it may have had an accidental origin. The witness would then have to determine whether the wounded person died from the wound inflicted by himself or from that which he had previously received. (See *Tetanus, post.*)

It may happen that the wounded person has taken *poison*, and has actually died from its effects, and not from the injuries or maltreatment. Again, a wounded person may have been the subject of subsequent ill-treatment, and the question will arise—to which of the two causes his death was really due. It is to be observed of these cases, that the supervening disease, the poison, or the subsequent ill-treatment, should be of such a nature as to account for *sudden or rapid death*; since it would be no answer to a charge of death from violence, to say that there were marks of chronic disease in the body, unless it was of such a nature as to account for the sudden destruction of life under the symptoms which actually preceded death. In the medical jurisprudence of wounds there is probably no question which so frequently presents itself as this: it is admitted that the violence was inflicted, but it is asserted that death was due to some other cause, and the onus of proof lies on the medical evidence. Among numerous cases which have occurred in England during the last

twenty years, I find that the *latent causes of death* in wounded persons have been chiefly inflammation of the thoracic or abdominal viscera, apoplexy, diseases of the heart and large blood-vessels, phthisis, ruptures of the stomach and bowels from disease, internal strangulation, and the rupture of deep-seated abscesses. In some of these cases the person was in a good state of health up to the time of the violence, and in others there was a slight indisposition. The history is nearly the same in all: it was only by careful conduct on the part of the medical witnesses that the true cause of death was ascertained. It is obvious that questions of malapraxis and life-insurance, giving rise to civil actions, may have a close relation to this subject.

Death following slight personal injuries.—An imputation has occasionally been thrown on the master of a school, when a boy has died soon after he has been punished in an ordinary way, and when there has been no suggestion that an undue amount of violence was used. In such cases there has been commonly some unhealthy state of the body to explain the result. When the disease which gives rise to doubt is seated in a part which is remote from that which sustained the violence, all that is required is, that the examination of the body should be conducted with ordinary care. If the disease should happen to be in the part injured (the head or chest), the case is more perplexing. The difficulty can then be removed only by attentively considering the ordinary consequences of such injuries. The violence may have been too slight to account for the diseased appearance; and the disease itself, although situated in the part injured, may be regarded as an unusual consequence of such an injury. On the other hand, the presence of chronic disease will form no exculpation of acts of violence of this nature. In *Reg.* v. *Hopley*, p. 561, there was chronic disease of long standing in the brain of deceased, but it was proved that he was quite well and suffered from no unusual symptoms up to the time that a violent flogging was inflicted, and that this was followed by death in less than three hours from the commencement of the violence. It was not here a question even of acceleration, for the deceased might have lived for years in spite of the existence of this chronic disease.

In some cases slight blows have been followed by fatal consequences, even when no disease existed to account for the result. Mr. Annan describes a case in which a healthy girl of four received a slight blow on the shin, about three inches below the knee, from the shaft of a wheelbarrow. There was pain but no external mark of violence. The injury was considered to be so slight as to require no special treatment. On the following day there was increased pain. Severe constitutional symptoms set in, and the child died on the fourth day. ('Med. Times,' August 1854.)

The following cases furnish additional illustrations of death after slight personal injuries, in which the medico-legal question requiring solution was simply, whether the death was a sequence or consequence of the violence:—A boy was struck two blows on the face by a magistrate; but it did not appear that they were very severe. The boy went to his work on the following day, but complained of pain in his head: he continued to work for two days, when he was seized with such severe pain that he was obliged to keep to his bed. He became worse, and died fourteen days after the injury. A minute inspection of the body was made, but the only morbid appearance found was a small tumour on the outer membrane of the brain, corresponding to the posterior face of the petrous portion of the right temporal bone. This satisfactorily accounted for death, but the examiners very properly denied that it had proceeded from the violence, because, 1, the tumour had evidently been for a long time forming; and many months before he was struck, the deceased had complained of his head. 2. It was also wholly improbable that the slight blows would, under any circumstances, have given rise to the formation of this deep-

seated fungous excrescence. (Henke, 'Zeitschrift der S. A.' 1837.) A case illustrative of these singular coincidences is reported to have been the subject of a criminal trial in the United States in 1842. A man was stabbed by his wife during a quarrel at a theatre, and he died in about ten minutes. It was supposed that the deceased had died from his wounds, which consisted of two stabs on the right arm, and one in the region of the stomach; and the prisoner, who believed that she had caused her husband's death, was charged with the murder. From the medical evidence given at the trial, it appeared that there was a large quantity of blood effused in the abdomen, and that the weapon had only perforated the stomach, without dividing any considerable blood-vessel to account for such a copious effusion. It was found that this had proceeded from the rupture of an aneurism of the aorta, the walls of which were so much thinned, that the least excitement was, in the opinion of the witness, sufficient to cause the accident. The aneurismal tumour was out of the reach of the knife, which had not penetrated in the direction in which it was lying. The witness admitted that wounds of the stomach were always dangerous, but that sudden death was not a usual consequence of a slight puncture. The prisoner was acquitted. In other instances the case may be of a very doubtful character. A good illustration of this will be found in the 'Med. Gaz.' vol. 20, p. 503, in a case reported by the late Dr. Hughes, where a boy died apparently from the effects of a blow on the side; and after death, peritonitis, ulceration of the bowels, an aperture in the diaphragm, and gangrene of the lungs were found. The following case, related by Morgagni, is remarkable in this point of view. An old man was caught in the act of robbing an orchard: he attempted to escape, but while running away the owner struck him a blow on the back. The old man went on a few yards, and then fell dead. On inspecting the body, there were no external marks of violence. There was a large effusion of blood in the chest, which was traced to a rupture of the aorta, probably from the vessel being in an aneurismal state. The blow appeared to have been slight, and would probably have produced no injurious consequences in a healthy person. (Barzellotti, 'Questioni di Medicina Legale.')

CHAPTER 42.

WOUNDS INDIRECTLY FATAL—DEATH FROM WOUNDS AFTER LONG PERIODS—SECONDARY CAUSES OF DEATH—THE CAUSE IS UNAVOIDABLE—THE CAUSE AVOIDABLE BY GOOD MEDICAL TREATMENT—COMPARATIVE SKILL IN TREATMENT—CAUSE AVOIDABLE BUT FOR IMPRUDENCE ON THE PART OF THE WOUNDED PERSON—ABNORMAL OR UNHEALTHY STATE OF THE BODY—ACCELERATION OF DEATH.

Wounds indirectly fatal.—Certain kinds of injuries are not immediately followed by serious consequences, but a wounded person may die after a longer or shorter period of time, and his death may be as much a consequence of the injury as if it had taken place on the spot. The aggressor, however, is just as responsible as if the deceased had been directly killed by his violence, provided the fatal result can be traced to the usual and probable consequences of the injury. Wounds of the head are especially liable to cause death insidiously,—the wounded person may in the first instance recover,—he may appear to be going on well, when, without any obvious cause, he will suddenly expire. It is scarcely necessary to observe, that in general an examination of the body will suffice to determine whether death is to be ascribed to the wound or not. In severe injuries affecting the spinal marrow, death is not an imme-

diate consequence, unless that part of the organ which is above the origin of the phrenic nerves (supplying the diaphragm) is wounded. Injuries affecting the lower portion of the spinal column do not commonly prove fatal until after some days or weeks; but the symptoms manifested by the patient during life, as well as the appearances observed in the body after death, will sufficiently connect the injury with that event. Death may follow a wound, and be a consequence of that wound, at almost any period after its infliction. It is necessary, however, in order to maintain a charge of homicide, that death should be strictly and clearly traceable to the injury, and not be dependent on any other cause. A doubt on this point must, of course, lead to an acquittal of the accused.

Death from wounds after long periods.—Many cases might be quoted in illustration of the length of time which may elapse before death takes place from certain kinds of injuries,—the injured person having ultimately fallen a victim to their indirect consequences. A case is related by Sir A. Cooper, of a gentleman who died from the effects of an injury to the head received about *two years* previously. The connection of death with the wound was clearly made out by the continuance of the symptoms of cerebral disturbance during the long period which he survived. Another case is mentioned by Hoffbauer, in which a person died from the effects of concussion of the brain as the result of an injury received eleven years before. ('Ueber die Kopfverletzungen,' 1842, p. 57.) In a case read before the Anatomical Society of Paris, a person received a musket-shot in the left side of the chest, and the ball remained lodged in the left lung during a period of *twenty-five years*. The ball, in penetrating, had fractured the humerus at its neck, in consequence of which the upper extremity had been amputated at the shoulder-joint. The wound of the chest soon healed, but the patient remained during life subject to fits of suffocation and hæmoptysis, under the effects of which he at length sank. On an examination of his body, the ball was found lying behind the third intercostal space in the midst of the pulmonary tissue, but lodged in a kind of cyst which communicated with the large air-tubes. Dr. Moore reports a case in which a person died fifty years after the receipt of a wound. ('Lancet,' Jan. 16th, 1847.) Alison quotes several cases in which persons have been found guilty of homicide—the injured persons having died from the indirect results of the wounds after the lapse of three and five months, and longer. ('Criminal Law,' p. 151.) In the case of Mr. Smith, who was shot by *Ross Touchet*, July 1844, death did not take place until after the lapse of eleven months from the time at which the wound was inflicted. In June 1839, a boy was admitted into Guy's Hospital for an injury to the spine, which proved fatal only after the lapse of eleven months. Among reported medico-legal cases, the *longest* interval at which a conviction has taken place from indirectly fatal consequences, was *nine months*. It was in the case of *Reg.* v. *Valus*. (Devizes Summer Ass. 1847.) It was proved that the prisoner had maltreated the deceased in September 1846. After this she suffered in her health, and in December she was found labouring under *phthisis*. She died of the disease in the following May. Two medical men deposed that they found, on examining the body, that three ribs had been broken on the left side—and the injury had evidently not been attended to. They thought that the irritation caused by the fracture in September might have led to the development of phthisis, although the seeds of the disease might have been long lurking in the system. The judge left it to the jury as a question depending on medical evidence, and they had to consider whether the consumption was caused, or the death of the deceased hastened, by the violence of the prisoner. They returned a verdict of guilty.

There is a singular rule in our law relative to the period at which a person

dies from a wound—namely, that the assailant shall not be adjudged guilty of homicide, unless death takes place *within a year and a day* after the infliction of the wound. ('Archbold,' p. 345.) In practice, the existence of this rule is of little importance, but in principle it is erroneous. Most wounds leading to death generally destroy life within two or three months after their infliction: sometimes the person does not die for five or six months, and, in more rare instances, death does not ensue until after the lapse of twelve months, or even several years. These protracted cases occur especially in respect to injuries of the head and chest. Dr. Reid met with the following case:—A man was admitted into the Edinburgh Infirmary, labouring under vomiting and difficulty of breathing, with severe pain on the left side of his chest. He died in four hours, and on inspection it was found that part of the large intestines (colon) and the omentum had passed into the chest through an aperture in the diaphragm. There was a cicatrix in the muscle with which the intestine was incorporated, showing that the injury was of very old date. The man had died from phrenic, or diaphragmatic hernia, and it turned out that he had received a wound about *fifteen months* previously, in the lower part of the left side of the chest, with a shoemaker's knife. This took place during a quarrel with a woman with whom he cohabited, but she was liberated on his apparent recovery. It seems that he had been attacked with severe pain in the abdomen (ileus), and had been in the infirmary on two different occasions subsequently to the wound, but had been dismissed each time apparently cured. ('Physiological Researches,' p. 523.) There was no doubt, although more than a year and a day had elapsed, that the stab was indirectly the cause of the man's death. In *Reg.* v. *Hynes* (Winchester Summer Assizes, 1860), it was proved that the prisoner had inflicted severe wounds on the head of deceased, and that death took place two months afterwards. The medical witnesses were perfectly agreed that death was caused by an abscess in the brain as a result of these wounds. The jury had great difficulty in finding a verdict of guilty, because in their opinion too long a time had elapsed for the injuries to have been the cause of death! But for the firmness of the judge, the prisoner would have escaped conviction, and would have owed that escape to the profound ignorance of the jury who tried him. Strict justice demands that the responsibility of a person who has inflicted a wound, should depend upon its having really caused death, and not upon the precise period at which death takes place; for this must be a purely accidental circumstance.

Secondary causes of death.—A person who recovers from the immediate effects of a wound may die from fever, inflammation or its consequences, pyæmia, erysipelas, delirium tremens, tetanus, or gangrene; or an operation required during the treatment of a wound may prove fatal. These are what may be called secondary causes of death, or secondary consequences of a wound. The power of deciding on the responsibility of an accused person for an event which depends only in an indirect manner on an injury originally inflicted by him, rests of course with the authorities of the law. But it is impossible that they can decide so difficult and nice a question in the absence of satisfactory medical evidence; and on the other hand, it is right that a medical witness should fully understand the importance of the duty here required of him. *Fever or erysipelas* may follow many kinds of serious wounds, and in some few instances be distinctly traceable to them; but in others, the constitution of a person may be so broken up by dissipated habits as to render fatal a wound which in a healthy subject might have run through its course mildly, and have healed. When the fever or erysipelas can be traced to a wound, or there is no other apparent cause of aggravation to which either of these disordered states of the body can be attributed, they can scarcely be regarded by a medical practitioner as unexpected and unusual consequences, especially when the injury is exten-

sive, and seated in certain parts of the body, as in the scalp. If death takes place under these circumstances, the prisoner will be held as much responsible for the result as if the wound had proved directly mortal. This principle has been frequently admitted by our law, and, indeed, were it otherwise, many reckless offenders would escape, and many lives would be sacrificed with impunity. It is, however, difficult to lay down general rules upon a subject which is liable to vary in its relations in every case; but when a wound is not serious, and the secondary cause of death is evidently due to constitutional peculiarities from acquired habits of dissipation, the ends of justice are probably fully answered by an acquittal; in fact, such cases do not often pass beyond a coroner's inquest.

The secondary causes of death may be arranged under the following heads:—

1. *The cause is unavoidable.*—Of this kind are tetanus, following laceration of tendinous and nervous structures,—erysipelas following lacerated wounds of the scalp,—peritoneal inflammation following blows on the abdomen with or without rupture of the bladder or intestines, and effusion of their contents,—strangulation of the intestines (phrenic hernia), following rupture or wounds of the diaphragm, and others of a like nature. Here, supposing proper medical treatment and regimen to have been pursued, the secondary cause of death was unavoidable, and the fatal result certain.

2. *The cause avoidable by good medical treatment.*—There are, it is obvious, many kinds of wounds which, if properly treated in the first instance, may be healed and the patient recover, but when improperly treated they prove fatal. In the latter case, it will be a question for a witness to determine how far the treatment aggravated the effects of the violence, and from his answer to this, the jury may have to decide on the degree of criminality which attaches to a prisoner. Let us suppose, for instance, that an ignorant person has removed a clot of blood, which sealed up the extremity of a blood-vessel, in consequence of which fatal bleeding has ensued—or that he has caused death by unnecessarily interfering with a penetrating wound of the chest or abdomen—it would not be just to hold the aggressor responsible, since, but for the gross ignorance and unskilfulness of his attendant, the wounded person might have recovered from the effects of the wound. When death is really traceable to the negligence or unskilfulness of a surgeon who is called to attend on a wounded person, this circumstance ought to be, and commonly is, admitted in mitigation, supposing that the wound was not originally of a mortal nature. Lord Hale observes:—'It is sufficient to constitute murder, that the party dies of the wound given by the prisoner, although the wound was not originally mortal, but became so in consequence of negligence or unskilful treatment; but it is otherwise where death arises not from the wound, but from unskilful applications or operations used for the purpose of curing it.' (I. 428.) The medical jurist will perceive that a very nice distinction is here drawn by this great judge, between death as it results from a wound rendered mortal by improper treatment, and death as it results from improper treatment, irrespective of the wound. In the majority of cases such a distinction could scarcely be established, except upon speculative grounds, and in no case, probably, would there be any accordance in the opinions of medical witnesses. In slight and unimportant wounds, it might not be difficult to distinguish the effects resulting from bad treatment from those connected with the wound, but there can be few cases of severe injury to the person, wherein a distinction of this nature could be safely made; and the probability is, that no conviction for murder would now take place, if the medical evidence showed that the injury was not originally mortal, but only became so by unskilful or improper treatment. In such a case, it would be impossible to ascribe death to the wound, or to its usual or probable consequences;

and without this it is not easy to perceive on what principle an aggressor could be made responsible for the result.

3. *Comparative skill in treatment.*—If death has been caused by a wound, it signifies not that, under more favourable circumstances, and with *more skilful treatment*, a fatal result might have been averted. As an illustration, the following case, reported by Alison, may be quoted:—The prisoner was one of a party of smugglers who fired at an officer of excise. The wounded man was carried to the nearest village, where he was attended by a surgeon of the country, who was not deficient in attention. A great collection of matter formed in the leg, fever ensued, and the patient died at the end of three weeks. In defence, it was urged that, by *skilful* treatment, the man might have recovered; but the Court held that it was incumbent to prove that death arose *ex malo regimine.* The true distinction in all such cases is, that if the death was evidently occasioned by grossly erroneous medical treatment, the original author of the violence will not be answerable; but if it arise from the want merely of the higher skill which can be commanded only in great towns, he will be responsible, because he has wilfully exposed the deceased to a risk from which he had practically no means of escaping. ('Criminal Law of Scotland,' p. 150.) In the case of *Macewan* (Perth, Sept. Circ. 1830), the prisoner was indicted for the manslaughter of a boy, by striking him a blow on the shoulder, which dislocated the arm. Two days after the blow, an ignorant bone-setter was consulted, and owing to his manipulations inflammation took place, and the boy being of a sickly and scrofulous habit, this proved fatal. Under the direction of Lord Meadowbank the prisoner was acquitted. In charging the grand jury, in reference to Mr. *Seton's* case (Winchester Aut. Ass. 1845), Platt, B., is reported to have observed, that if a man inflict a wound likely to produce death, and the wounded party should fall into the hands of an unskilful practitioner, whereby death was hastened, the aggressor would still be responsible for the result. If the wound had not been likely to produce death, but by unskilful treatment death ensued, then that would not be murder. A case of this kind was tried at the Lewes Summer Assizes, 1858 (*Reg.* v. *Kingshott*). A man in a quarrel received a bite on his thumb. He went to a quack, who applied some irritating ointment, which led to severe inflammation, and this rendered amputation of the arm necessary. He died from the effects of the operation. There was evidence that the original injury was slight, and would probaby have healed but for the improper applications. On this evidence the prisoner was acquitted.

It will be obvious that a serious responsibility is thrown on practitioners who undertake the management of cases of criminal wounding. Any deviation from common practice should therefore be made with the greatest caution, since novelties in practice will, in the event of a fatal result, form one of the best grounds of defence in the hands of a prisoner's counsel. On these occasions every point connected with the surgical treatment will be the subject of rigorous inquiry and adverse professional criticism. In the case of a severe lacerated wound in the hand or foot followed by fatal tetanus, it may be said that the wounded person would not have died had amputation been at once performed. In this instance, however, a practitioner may justify himself by showing either that the injury was too slight to require amputation, or that the health or other circumstances connected with the deceased would not allow of its being performed with any reasonable hope of success. On the other hand, if the practitioner performed amputation, and the patient died, then it would be urged that the operation was premature, wholly unjustifiable, and that it had caused death. Here the surgeon is bound to show that the operation was necessary, according to the ordinary rules of practice. The treatment of severe incised wounds of the throat, when the windpipe is involved, sometimes places a practitioner in an embarrassing position. If the wound is left open, death may take place

from bleeding; if it be prematurely closed, blood may be effused into the windpipe and cause death by suffocation.

The following case occurred a few years since in London:—A man inflicted a transverse wound on his throat; it was about four inches in length, and passed across the middle of the larynx. The bleeding was not considerable, as the carotid arteries had escaped being wounded. The external orifice had, in the first instance, been closed, and the patient was almost suffocated, partly by the occurrence of emphysema, and partly by the blood flowing into the windpipe. On opening the wound the patient's breathing was relieved, and a quantity of mucus mixed with blood was thrown out at each expiration. After waiting some time, the pieces of divided cartilage were brought together by sutures, and the wound carefully closed. In a short time the breathing became difficult, the countenance livid, and the man died apparently suffocated. Another case occurred in the neighbourhood of London, in June 1841. A woman was found in bed one morning with her throat severely cut, and a man was charged with the crime of murder. The wound had divided the windpipe and the superficial vessels. Although medical assistance was called in, it appears that nothing was done to arrest the bleeding for three-quarters of an hour. The wound was then closed by ligatures, and the woman died immediately—most probably from suffocation. The accused was tried and acquitted, because it appeared that this was an act of suicide. The first object of the surgeon, in all such cases, is to save life: therefore the bleeding should be immediately arrested by securing the divided vessels. When this is done, the wound may be closed, but if the closure takes place before this, death from suffocation will commonly follow.

4. *The cause avoidable but for imprudence or neglect on the part of the wounded person.*—A man who has been severely wounded in a quarrel may obstinately refuse medical assistance, or he may insist upon taking exercise, or using an improper diet, contrary to the advice of his medical attendant; or, by other imprudent practices, he may thwart the best conceived plans for his recovery. Let us take a common case as an illustration. A man receives a blow on the head in a pugilistic combat, from the first effects of which he recovers, but after having received surgical assistance he indulges in excessive drinking, and dies. The aggressor is tried on a charge of manslaughter, and found guilty. Death under these circumstances is commonly attributed by the medical witness to effusion of blood on the brain; but it cannot be denied that the excitement produced by intoxicating liquors will sometimes satisfactorily account for the fatal symptoms. In the case which we are here supposing, such an admission might be made, and the prisoner receive the benefit of it; for the imprudence or negligence of a wounded person ought not, morally speaking, to be considered as adding weight to the offence of the aggressor. If the symptoms were from the first unfavourable, or the wound likely to prove mortal, circumstances of this kind could not be received in mitigation. Our judges are at all times unwilling to admit them. In the case of the notorious *Governor Wall*, who was convicted and executed many years ago for causing the death of a man by excessive punishment, it was attempted to be shown in evidence that the deceased had destroyed himself by the immoderate use of spirits while under treatment in the hospital. The Lord Chief Baron, in charging the jury, observed that no man was authorized to place another in so perilous a predicament as to make the preservation of his life depend merely on his own prudence. The more clearly the medical witness is able to trace death to imprudence or excess on the part of the deceased, in the case of a *slight* wound, the more obviously would the responsibility of a prisoner be diminished; and hence the necessity for attending carefully to the progress of a wound, which, if it prove fatal, may involve another in a criminal charge. In the case of *Christian*

Paterson (1823), referred to by Alison (p. 147), it appeared in evidence that the deceased was struck on the head with a smoothing-iron, which fractured her skull; some days afterwards she drank a quantity of whisky, and was ultimately taken to the Royal Infirmary, where erysipelas shortly appeared in the wound, of which she died. Under these circumstances the charge of murder was abandoned, and the accused was found guilty of assault. The legal responsibility of the assailant is the same, whether the deceased die on the spot, or some days, weeks, or months afterwards, unless it can be distinctly proved that his death was immediately connected with the imprudence or excess of which he was guilty, and wholly independent of the wound. But although a prisoner should be found guilty of manslaughter under these circumstances, the punishment is so adjusted by our law as to leave a considerable discretionary power in the hands of a judge. This is, indeed, tantamount to a direct legal provision, comprehending each different shade of guilt; a man is held responsible for a wound rendered accidentally mortal by events over which he could have no control, and which in themselves ought to be regarded as in some degree exculpatory. The punishment attached to his offence may be severe or slight, according to the representation made by a medical witness of the circumstances which rendered the wound mortal; if he neglect to state the full influence of imprudence or excess on the part of the wounded person, where either has existed, over the progress of the wound, he may cause the prisoner to be punished with undue severity. The humanity of our judges is such, that when medical evidence is clear and consistent on a point of this nature, and there are no circumstances in aggravation, they commonly pass a mild sentence. (See case by M. Ollivier, 'Ann. d'Hyg.' 1842, p. 128.) The neglect to call in a medical practitioner, or the refusal to receive medical advice, will not, however, according to the decision in *Reg.* v. *Thomas* (Gloucester Autumn Assizes, 1841), be considered as a mitigatory circumstance in favour of the prisoner, even although the wound was susceptible of being cured. A man may receive a lacerated wound of a limb, which is followed by tetanus or gangrene, and thus proves fatal; he may have declined receiving medical advice, or have obstinately refused amputation, although proposed by his medical attendant. This would not operate as a mitigatory circumstance on the part of an assailant, because a wounded person is not compelled to call for medical assistance, or to submit to an operation, and a medical witness could not always be in a condition to swear that the operation would have positively saved his life; he can merely affirm that it might have afforded him a better chance of recovery. In the case of *The Queen* v. *Hulme* (Liverpool Autumn Assizes, 1843), it was proved that the deceased had died from tetanus caused by an injury to a finger some time before. Amputation was advised by the surgeon, but the deceased would not consent to the operation. The prisoner was convicted of manslaughter, and sentenced to the severest punishment prescribed by the law for that crime. In the case of *Mackenzie* (1827), the prisoner seized deceased by the throat, and bruised him severely in several parts of the body, in consequence of which tetanus supervened, and he died. Skilful medical advice was not called in until near the end of the illness, when tetanus had already come on, and in the interval deceased had acted imprudently and had aggravated the symptoms. The medical evidence clearly proved that the tetanus was owing to the injury, and was a frequent result of it. The prisoner, under the direction of the Court, was convicted, and subsequently transported. Again, a person may receive a blow on the head, producing fracture, with great depression of bone, and symptoms of compression of the brain: a surgeon may propose an operation to elevate or remove the depressed bone, but the friends of the wounded man may not permit the operation to be performed. In such a case his line of duty will be to state the facts to the Court,

and it is probable that in the event of conviction there would be some mitigation of punishment; because such an injury, if left to itself, must in general prove mortal, and no doubt could exist in the mind of any surgeon as to the absolute necessity for the operation. But the neglect or improper conduct of a person who receives a wound thus rendered fatal, does not exculpate the aggressor. The crime is either murder or manslaughter.

5. *The cause avoidable but for an abnormal or unhealthy state of the body of the wounded person.*—Wounds which are comparatively slight sometimes prove indirectly fatal, owing to the person being in an unhealthy condition at the time of their infliction. In bad constitutions compound fractures or slight wounds, which in a healthy person would have a favourable termination, are followed by gangrene, fever, or erysipelas, proving fatal. Here the responsibility of an assailant for the death may become reduced, so that, although found guilty of manslaughter, a mild punishment might be inflicted. The consequence may be, medically speaking, unusual or unexpected, and, but for circumstances wholly independent of the act of the accused, would not have been likely to destroy life. In general, in the absence of malice, this appears to be the point to which the law closely looks, in order to make out the responsibility of the accused, namely, that the fatal secondary cause must be something not unusual or unexpected as a consequence of this particular injury. The medico-legal question presents itself under this form:—Would the same amount of injury have been likely to cause death in a person of ordinary health and vigour? Men who have suddenly changed their habits of living, and have passed from a full diet to abstemiousness, are sometimes unable to bear up against comparatively slight injuries, and often sink from the secondary consequences. So a man otherwise healthy labouring under rupture may receive a blow on the groin, attended with laceration of the intestine, gangrene and death; another with a calculus in the kidney may be struck in the loins, and die, in consequence of the calculus perforating the blood-vessels, and causing fatal bleeding, or subsequent inflammation. Mr. Crosse, of Norwich, reported to the Medico-Chirurgical Society the case of a boy, aged ten, who received a slight blow on the abdomen, and died in an unexpected manner on the second day after the injury. On inspection, a cyst, capable of holding ten or twelve ounces of liquid, was found connected with the under surface of the liver. The cyst had been ruptured by the blow, and its contents had escaped into the abdomen. But for the cyst existing in this situation, the blow would not have been attended with dangerous consequences. In these cases the effects of the violence must be regarded as something unexpected: it would not have produced serious mischief in an ordinarily healthy person, and hence the responsibility of an assailant becomes much diminished. The crime is undoubtedly manslaughter, but the punishment may be of a lenient description. A defence of this kind will, however, be limited by circumstances. A case is reported, in which a Dr. *Fabricius* was tried at the Old Bailey for the murder of his female servant by striking her a blow behind the ear, whereby a large abscess, situated at that part, was ruptured, and this ultimately caused her death. The chief question on the trial was, whether the deceased had died from the effects of the violence, or from the disease under which she was at that time labouring. The doctor ingeniously urged in his defence that he had struck the blow merely for the purpose of opening the abscess! The jury, however, did not agree in taking this professional view of the matter, and they found him guilty of manslaughter. In the case of *The Queen* v. *Bell* and others (Notts Autumn Assizes, 1841), it was proved that the deceased had died from the effects of a blow received in a prize-fight, which had ruptured an abscess in the kidney, evidently of long standing. The prisoners were convicted. In the case of *Bennett* v. *Gredley* (Exchequer

Sittings, Hilary Term, 1854), which was a suit for compensation by reason of injuries inflicted on a boy's arm, it was argued in defence that the state of the arm was partly owing to a former injury; in reference to which the Chief Baron remarked, that a man was not bound to have his body in so sound and healthy a state as to warrant an unauthorized assault upon him. A man, therefore, who commits an unauthorized assault upon his fellow-man must take his chance of the effects which such an assault may produce. In the case of *The Queen* v. *Wallis*, for murder (Cambridge Summer Assizes, 1864), the medical evidence showed that the deceased, an aged lady, had received several wounds and bruises on her face and head, and a severe contusion on the right side of her chest. There was a fracture of the ulna near the wrist, and she had lost much blood. After lying in danger for some days her condition improved, but she again got worse, and died nineteen days after the infliction of the injuries. On inspection it was found that beneath the contusion of the chest, three ribs were broken but not displaced. There was disease of the valves of the heart of long standing, and it was proved that she had suffered from spasms in this region before the assault. The cause of death assigned by the witnesses was spasmodic seizure affecting the organs of the chest, principally the heart. The injuries which the deceased had received had lowered her system, and had rendered it less likely that she could recover from a spasmodic attack. In defence it was urged by the counsel for the prisoner, that if in any case the cause of death be partly traceable to injuries and partly to natural or other causes, a prisoner is entitled to an acquittal. In support of this view he quoted the case of *Johnson*, from Lewis's C. C., vol. 1, p. 164. The objection was overruled by the judge (Channell, B.), who held that it was bad law in the face of recent decisions. There can be no doubt, that but for the injuries inflicted, the woman would not have died; therefore, the act of the prisoner was the moving cause of her death. In cases of a mixed character this is probably the best test to determine the share which the alleged violence, when not strictly of a mortal nature, had in the death of a wounded person. By adopting such a course as was taken on this occasion, the cause will be sufficiently defined for the guidance of a jury. As a rule, cases of this description are determined by the question, whether the violence, although not the immediate, was the accelerating cause of death.

It must be evident that there exist numerous internal diseases, such as aneurism and various morbid affections of the heart and brain, which are liable to be rendered fatal by *slight* external violence. In *Reg.* v. *Marris* (Swansea Lent Assizes, 1872), the prisoner was convicted of manslaughter under the following circumstances. He struck the deceased a blow on the side of the head, which caused him to stagger and fall. On inspection the heart was found to be in an advanced state of fatty degeneration. It was admitted by counsel for the prosecution that the blow would not of itself have produced any serious injury to a healthy man, but that in the case of the deceased it had accelerated his death, and would be likely to do so with a man suffering from heart disease. In the case of a Mr. *Wyld*, April 1872, the evidence showed that deceased had received a blow on the head, producing a slight wound, but insufficient to cause, or even, in the opinion of the medical witness, to accelerate the death of deceased. An inspection showed that there was fatty degeneration of the heart, and that this was the sole cause of death. The law, as applied to these cases, is thus stated by Lord Hale:—'It is sufficient to prove that the death of a person was accelerated by the malicious act of the prisoner, although the former laboured under a mortal disease at the time of the act' (vol. 1, p. 428). In those cases in which a slight degree of violence has been followed by fatal consequences, it is for a jury to decide, under all the circumstances, upon the actual and specific intention of the prisoner at the time of

the act which occasioned death. According to Starkie, 'it seems that in general, notwithstanding any facts which tend to excuse or alleviate the act of the prisoner, if it be proved that he was actuated by prepense and deliberate malice, and that the particular occasion and circumstances upon which he relies, were sought for and taken advantage of merely with a view to qualify actual malice, in pursuance of a preconceived scheme of destruction, the offence will amount to murder.' In most of these cases there is an absence of intention to destroy life, but the nature of the wound, as well as the means by which it was inflicted, will often suffice to develop the intention of the prisoner. An accurate description of the injury, if slight, may afford strong evidence in favour of the accused, since the law does not so much regard the means used by him to perpetrate the violence, as the actual intention to kill, or to do great bodily harm. Serious injury, causing death by secondary consequences, will admit of no exculpation when an assailant was aware, or ought to have been aware, of the condition of the person whom he struck. Thus, if a person notoriously ill, or a woman while pregnant, be maltreated, and death ensue from a secondary cause, the assailant will be held responsible; because he ought to have known that violence of any kind to a person so situated must be attended with dangerous consequences. So, if the person maltreated be an infant or a decrepit old man, or one labouring under a mortal disease, it is notorious that a comparatively slight degree of violence will destroy life in these cases, and the prisoner would properly be held responsible. A wound which *accelerates* death, *causes* death, and may therefore render the aggressor responsible for murder or manslaughter, according to the circumstances. The Commissioners appointed to define the criminal law on the subject of homicide thus express themselves: —'Art. 3. It is homicide, although the effect of the injury *be merely to accelerate the death* of one labouring under some previous injury or infirmity, or although, if timely remedies or skilful treatment had been applied, death might have been prevented.' This is conformable to the decisions of our judges. According to Lord Hale, if a man has a disease which in all likelihood would terminate his life in a short time, and another give him a wound or hurt which hastens his death, this is such a killing as constitutes murder. (Archbold, p. 345.) The case of *Reg.* v. *Murton* (Maidstone Winter Assizes, 1862) presents many points of interest in reference to the medico-legal question of the acceleration of death by violence. There was no mortal wound, and the deceased was in an unhealthy state of body. Nevertheless the prisoner was convicted of manslaughter.

6. *Abnormal conditions.*—When an assailant could not have been aware of the existence of a diseased or an abnormal condition of parts in the wounded person, the question is somewhat different. In many persons the skull is preternaturally thin, and in most persons it is so in those places corresponding to the glandulæ Pacchioni. In a case of this kind a moderate blow on the head might cause fracture, accompanied by effusion of blood, depression of bone, or subsequent inflammation of the brain and its membranes, any of which causes might prove fatal. A trial involving this question occurred at the Norwich Summer Assizes in 1842. (*The Queen* v. *Dowde.*) The prisoner, who was a policeman, was charged with manslaughter. The deceased, it appears, attempted to escape from the custody of the prisoner, and the latter, in endeavouring to prevent his escape, struck the deceased a blow on the head. The deceased spoke of the blow as trifling, and, with the exception of a slight headache, he made no complaint. On examining his head, there was a slight cut, with a small effusion of blood. The deceased was placed in a cell, and some hours afterwards was found dead. On inspection, the skull was found fractured for an inch-and-a-half over the seat of violence, and a quantity of blood had been effused and had caused death. The medical evidence on the

trial was to the effect, that the blow did not appear to have been violent, that the skull of the deceased was preternaturally thin, not being more than one-twelfth of an inch in thickness at the fractured part. All agreed that a fracture might in this case have been caused by a blow, which, under ordinary circumstances, would have been attended with no serious mischief. In some persons, all the bones of the body are unusually *brittle*, so that they are fractured by the slightest force. Inflammation, gangrene, and death may follow, when no considerable violence has been used; but these being unexpected consequences, and depending on an abnormal condition of parts unknown to the assailant, his responsibility may not, *cæteris paribus*, be so great as under other circumstances. This condition of the bones can be determined only by a medical practitioner. Facts of this kind show that the degree of violence used in an assault cannot always be measured by the effects, unless a careful examination of the injured part is previously made.

Some German medical jurists have contended that an unnatural transposition of parts should become an extenuating circumstance—as when, for example, the heart or some large vessel is not in its usual position, and is there wounded; but this doctrine will receive no sanction from an English Court of Law, as the responsibility of persons for these criminal offences does not rest upon the perfect anatomical structure of the deceased! At the same time, it might become a question whether, if death occurred from a superficial wound, whereby a large artery taking an abnormal course was divided—there might not be, *cæteris paribus*, some ground for diminishing the degree of responsibility.

7. *Difficulty of proof in death from secondary causes.*—When a person is charged with having caused the death of another through violence terminating in some fatal disease, the case often admits of a skilful defence, and this in proportion to the length of time after the violence of which the deceased dies. The disease, it may be urged, is liable to appear in all persons, even the most healthy; or it may arise from causes unconnected with the violence. In admitting these points, it must be remembered that death may be proved to have been indirectly a consequence of the wound by the facts: 1, that the supervention of the secondary cause, although not a common event, lay in the natural course of things; 2, that there did not exist any accidental circumstances which were likely to have given rise to this secondary cause independently of the wound. The proof of the first point amounts to nothing, unless the evidence on the second point is conclusive.

CHAPTER 43.

WOUNDS INDIRECTLY FATAL. TETANUS FOLLOWING WOUNDS — ERYSIPELAS — PYÆMIA—DELIRIUM TREMENS—DEATH FROM SURGICAL OPERATIONS—PRIMARY AND SECONDARY CAUSES OF DEATH — UNSKILFULNESS IN OPERATIONS—NECESSITY FOR OPERATIONS—USE OF CHLOROFORM IN OPERATIONS—REFUSAL TO SUBMIT TO AN OPERATION—OPERATIONS UNDER MISTAKEN OPINIONS—FATAL DISEASES FOLLOWING OPERATIONS—CHARGES OF MALAPRAXIS.

Tetanus following wounds.—This disease frequently presents itself as a secondary fatal consequence of wounds, especially of those which are lacerated or contused, and affect nervous or tendinous structures. It has often occurred as a result of slight bruises or lacerations, when the injury was so superficial as to excite no alarm; and it is a disease which gives no warning of its appearance. Dr. Brady met with a case in which a man slipped in walking, and fell flat on his back. He was stunned, but able to walk home. He apparently recovered from this simple accident, but on the following day he was attacked

with tetanus, and died in seventy hours. ('Lancet,' May 15, 1847 p. 516.) In the case of *Reg.* v. *Butcher* (Warwick Lent Assizes, 1848), it was proved by medical evidence that the deceased had received a blow on the nose, which caused severe bleeding. In spite of good surgical treatment, the man was attacked with tetanus on the fifteenth day, under which he sank. On inspection, it was found that one of the small bones of the nose had been broken, and this had given rise to the fatal attack. Tetanus may come on spontaneously, *i.e.* independently of the existence of any wound on the body. Cases have been brought into the London hospitals, in which the only cause of this disease appeared to be exposure to cold or wet, or, in some instances, exposure to a current of air. ('Lancet,' Dec. 14, 1844, p. 351.) Dr. Watson met with an instance in which tetanus appeared in a severe form in a man who had received no wound, but who had been simply exposed to cold and wet. (Cormack's 'Monthly Journal,' Dec. 1845, p. 902.) It has sometimes come on without any apparent cause. It is scarcely possible to distinguish, by the symptoms, tetanus from wounds (traumatic) from that which occurs spontaneously as a result of natural causes (idiopathic). In endeavouring to connect its appearance with a particular wound or personal injury, it will be proper to observe—1, whether there were any symptoms indicative of it before the maltreatment; 2, whether any probable cause could have intervened to produce it, between the time of its appearance and the time at which the violence was inflicted; 3, whether deceased ever rallied from the effects of the violence. The time at which tetanus usually makes its appearance, when it is the result of a wound (traumatic), is from about the third to the sixth day; but it may not appear until three or four weeks after the injury, and the exciting cause may still be traced to the wound which may have healed. When resulting from a wound it is generally fatal.

A medical practitioner is bound to exercise great caution before he pronounces an opinion that a fatal attack of tetanus has arisen either from spontaneous causes or from slight blows or personal injuries. A case occurred in St. Bartholomew's Hospital, in September 1853, which exemplifies the necessity of making a rigorous inquiry into all the attendant circumstances. A boy, æt. 15, while quarrelling with another, received a blow in the back from his companion's fist, and this was followed by a kick, but not of a severe character. He was able to get up and walk home; in about two hours he complained of stiffness of the lower jaw. He passed a restless night—the stiffness increased; there was great pain, and subsequently difficulty in swallowing. On the second day he was admitted into the hospital, the pain and stiffness gradually increased, and the jaw became partially fixed. Spasm of the muscles of the back supervened, occurring in paroxysms, and there was confirmed tetanus. He died on the fourth day after he had received the blow on the back, and apparently from tetanus, as a result of that violence. It turned out, however, on inquiry, that six days previously to the first appearance of the tetanic symptoms, the boy had accidentally driven a rusty nail into his foot, and that the suppurating wound which resulted from this injury had only closed on the day on which the blow was inflicted. On an examination of the body a small puckered cicatrix, such as would result from the healing of a punctured wound, was found on the ball of the great toe, and there could be no doubt from the circumstances, that this, and not the slight blows struck by the assailant, had been the cause of the fatal attack of tetanus. ('Lancet,' Dec. 10, 1853, p. 550.) This case has an important bearing on the question considered at p. 565. It is probable that many cases have been set down as idiopathic tetanus in which, by proper inquiry, the disease might have been traced to a concealed wound or some personal injury. In one instance the tetanus was at first considered to be idiopathic, but shortly before death a small black mark was observed on the thumb-nail.

On making inquiry, it was found that a few days previously to the attack a splinter of wood had accidentally penetrated the thumb. The patient attached so little importance to the accident that he did not mention the circumstance to his medical attendant. Two similar cases are reported by Dr. G. Johnson. ('Brit. Med. Jour.' 1872, Nov. 22, p. 594.)

Many trials for wounding have occurred in this country in which tetanus was the immediate cause of death; and the defence has generally rested upon the probable origin of the disease from accidental causes. Among these, that of Capt. *Moir*, who was tried at the Chelmsford Assizes in 1830 for the murder of a fisherman, is one of the most interesting, as it develops the rule of law in respect to criminal responsibility, when death takes place from a secondary cause. The deceased had frequently trespassed on the grounds of the prisoner, but, notwithstanding warnings which he had received, he set the prisoner at defiance. On the day laid in the indictment, the prisoner, while riding, met the deceased crossing his grounds, in order to pursue his usual occupation of fishing. An angry altercation took place, and the deceased refused to return. The prisoner, in a high state of irritation, then rode back to his house, which was at some distance from the spot, and, having procured his pistols, rode after the deceased, and overtook him in the act of continuing the trespass. Words again ensued between them, and the prisoner then fired at deceased and wounded him severely in the arm. The muscles, vessels, and nerves were extensively lacerated, but no question seems to have been raised respecting the propriety of immediate amputation. The deceased lingered a short time; tetanus supervened, from which he died. On the trial, at the Chelmsford Assizes, the medical evidence went to show that death was caused by tetanus, brought on by the severe gun-shot wound inflicted by the prisoner. In his defence, it was alleged that he shot the deceased under provocation, and that he had not intended to kill him, for he had purposely aimed at his arm. With regard to the first point, it was considered that the fact of his returning to his house, to fetch a weapon capable of inflicting a mortal wound, was evidence of deliberate malice; while, with regard to the second point, there could be no extenuation, since a serious wound inflicted on an arm or leg may destroy life as certainly as a wound inflicted on the trunk. The prisoner was found guilty and executed, but his execution was considered by many to be *summum jus*. In this case, the connection of the secondary cause of death with the original wound appeared to be so clear, that not a doubt existed in the minds of the professional witnesses; and the law held the prisoner to be as much responsible for the fatal result as if he had killed the deceased on the spot.

Erysipelas, like tetanus, may be a fatal result of slight injuries. Wounds affecting the scalp are liable to be followed by this disease. Burns and scalds may prove fatal either through tetanus or erysipelas as a secondary cause. Some constitutions are particularly prone to erysipelatous inflammation, and thus wounds, comparatively slight, may have a fatal termination. In *Reg.* v. *Littlewood*, for manslaughter (York Summer Assizes, 1858), it was proved that deceased had died from erysipelas consequent on a burn which he had received from an explosion of gas. The cause of death was clearly proved, but the evidence failed to show criminal negligence, and the prisoner was acquitted. On these occasions, in order to make an assailant responsible for the fatal result, the erysipelas must be clearly traced to the injury. The medical facts that the person assaulted has never recovered from the effects of the violence, and that the inflammation set up has suddenly assumed an erysipelatous character, are sufficient to establish this connection. If there has been recovery, and an interval of some days has elapsed, a doubt may arise respecting the connection of the erysipelas with the violence inflicted. This disease is occasionally idiopathic, *i.e.* it appears like tetanus without any assignable cause. In the following

case, which was the subject of a trial at the Central Criminal Court in July 1859, the erysipelas did not show itself until thirteen days after the injury, and it proved fatal on the seventeenth day.

A potman, stated to be of temperate habits, was struck on the left cheek with a quart pot. There was a contusion, but no injury to the skin. The man was slightly stunned by the blow, but was able, in less than an hour, to prefer a charge against the aggressor. From this time he did not appear to suffer any ill effects from the blow, and continued as usual at his work for a period of thirteen days after the receipt of the injury, when erysipelas of the ordinary character made its appearance. It commenced on the bridge of the nose and both eyes. Towards the close of the same day the man had an attack of delirium tremens; the erysipelas began to assume an unhealthy aspect on the sixteenth day, and he was then brought to St. Thomas's Hospital. The erysipelas was now general over the face and head, and delirium tremens was strongly marked. Death took place on the following afternoon, and at the post-mortem examination twenty hours after death, only slight congestion of the brain was found. At the coroner's inquest, on the medical witness (Dr. Clapton) being called, he was asked whether it was probable (as far as was currently known), that erysipelas could supervene upon a contused wound *thirteen days* after a blow. His reply was in the negative, and he expressed an opinion that the erysipelas could not be attributed to the blow. Hence the death of the man did not result indirectly from the blow, as was sought to be proved. The coroner, however, and the jury disregarded the medical evidence, and committed the man for trial. At the trial the same medical evidence of the cause of death having been given, the Recorder immediately directed the jury to acquit the prisoner, stating that there was no evidence to prove that the death had been in any way caused or hastened by the injury inflicted.

Dr. John Reid ('Physiological Researches,' p. 512) has pointed out a singular appearance in death from erysipelas which, unless the facts had been known, might have given rise to a serious mistake. A man died from erysipelas in the left leg. On uncovering the body twenty-four hours afterwards, for the purpose of inspection, it was observed that the skin over the fore and middle part of the leg affected with the erisypelas, had assumed a dark purple colour, resembling so strongly the appearance of ecchymosed blood consequent upon injury, that all who were present confessed that if they had not been aware of the previous history of the case, the appearance might have been attributed to some injury received during life. When, however, the apparently ecchymosed part had been cut into, it was found that no blood had been effused into the cellular tissue, but the skin was increased in thickness, and its vessels were loaded with dark blood.

It is sometimes difficult to establish the connection of *erysipelas* with a wound, especially when the disease occurs in a remote part of the body not implicated in the wound. When this cannot be distinctly made out, there will be an acquittal. The following case was tried before the Justiciary Court at Glasgow, in 1822. A gamekeeper to Lord Blantyre was indicted for the murder of a poacher, whom he shot so severely in the left arm, that it was found necessary to perform amputation above the elbow. The man died of erysipelas in the right leg; and the question on the trial was, whether the erysipelas was brought on by the gun-shot wound or not. Upon this question there was great difference of opinion among the medical witnesses. One gave it as his opinion that the debility caused by the wound brought on the disease of which the deceased died. Another thought that the tendency to erysipelas had existed long before the man received the wound. It appeared in evidence that the deceased had been out for two nights in the exercise of his vocation, and had slept without shelter; that during this time he had eaten but little; and,

above all, that he had an ulcer in his leg, the absorption of matter from which, in the opinion of some of the witnesses, had laid the foundation of the disease before the injury was received. 'Under these circumstances,' observes the reporter, 'what would have been the best mode of treatment in such a case, supposing the deceased had received no wound at all?' 'Undoubtedly, he continues, 'the very treatment which he did receive in consequence of it—copious bleeding, light diet, and perfect rest—while the counter-irritation from the amputation, so far from increasing the inflammation which was going on in the groin, must have acted like a blister or a seton in repressing and counteracting it!' The jury seem to have agreed in this view of the case, for the prisoner was acquitted of the charge. (Beck's 'Med. Jurisprudence, Wounds.') Taking the circumstances as they are above reported, it certainly did not appear that erysipelas was directly connected with the wound, and unless this had been clearly and satisfactorily proved, it would have been unjust to make the prisoner responsible for the fatal consequences. The bad habit of body and the actual existence of disease in the leg, were facts in themselves sufficient to render such an opinion improbable. But in addition to this, it is stated by Alison, that erysipelas was at the time prevalent in the Glasgow Infirmary, and that deceased was put into a bed formerly occupied by a patient labouring under this disorder. Until then the wound had presented no peculiarly dangerous symptoms.

A question of a similar kind arose in *Master* v. *The Blackpool Railway Company* (Liverpool Lent Assizes, 1868). It was an action for recovery of compensation for the death of the Archdeacon of Manchester. In a collision on the line he received a bruise on the shin. He complained of the injury at the time, and walked lame. In a few days phlegmonous erysipelas set in, and he soon afterwards died of pyæmia. It appeared that his wife was at the time suffering from phlegmonous erysipelas with sloughing sores on the leg, and for two or three days after the injury, the Archdeacon slept in his wife's room, and his leg was dressed by the servant who attended the wife. The injury itself appeared at first to be very slight, but after this it assumed a more serious character. On the part of the plaintiff it was urged that the erysipelas which had caused death, had supervened naturally on the injury to the leg, while it was contended for the Company that the erysipelas was induced by contagion or infection from sitting in the wife's bedroom with the wife, and did not naturally result from the injury. It was left to the jury to say whether or not the Archdeacon's sitting in the bedroom was a want of due care, or whether the disease which proved fatal had followed as a natural consequence from the blow. The jury found for the Company, on the ground that the plaintiff had sustained no pecuniary loss.

Delirium tremens is a disease which frequently presents itself as a secondary consequence of injuries to persons of intemperate habits. The injury may be slight or severe; the disease will equally supervene and may prove fatal. It is observed occasionally as a consequence of operations required for the treatment of wounded persons. The remarks made at page 575 upon the influence of unhealthy constitutions on wounds, apply with especial force to cases of this description. In the case of *Reg.* v. *Heywood*, C. C. C, October 29, 1846, it was proved that the deceased had been assaulted by the prisoner, but had not sustained any personal injury likely to be followed by serious consequences. Nevertheless, symptoms of delirium tremens came on, and he died in the course of a few days. It was alleged that the disease of which the deceased died was brought on by the violence, and the evidence of Mr. Coulson was adduced in support of this view. This gentleman deposed that he was called upon to attend the deceased on the day after the assault; his face was swollen and black, particularly on the right side, and there were two wounds on that side of the

face. He did what was necessary at the time, and the wounds were nearly healed. The deceased appeared to suffer from great tremulousness and weakness, and these constitutional symptoms continued to increase, although the wounds were rapidly healing, and the swelling had nearly subsided. Two days before his death the ordinary symptoms of delirium tremens came on, and of this he died. In Mr. Coulson's opinion death was attributable to a shock of the nervous system, causing delirium tremens; and he accounted for that shock by the attack made upon the deceased, and by the blows he had received. On a post-mortem examination he could not discover any fracture of the skull or of the bones of the face, or a rupture of any blood-vessel. The right lung was much congested, and there were some old adhesions to the chest. The left lung was also congested. The heart was large and flabby, but he did not discover anything in the examination of the body to account for death. He considered that the delirium tremens arose from the attack made upon the deceased, but he was certainly surprised to see so fatal a result from such slight injuries. By the Court.—He considered the blows the deceased had received were the exciting cause of delirium tremens. It was generally the result of violent injury, but he had known it to follow from slight blows. By the prisoner's counsel.—He should say, from the appearances he observed on the post-mortem examination, that the deceased was a 'bad subject.' The injuries the deceased had received were certainly not sufficient to account for the death of a healthy man. The shock to the system might have been produced by the deceased's excited condition, and delirium tremens might be occasioned by excitement alone. The skull of the deceased was remarkably thin, and if there had been any great violence, he should have expected to find the bones fractured. Excitement might produce delirium tremens, but, as there had been blows in this case, he thought it more natural to ascribe it to them than to mere excitement. If the system had not been in a bad state, the result would not have been so serious; but he considered the blows to have been the exciting cause of death. The judge asked if he was right in understanding the witness to allude to the moral effect of the blows, to the excitement they occasioned on the system, rather than to the actual result that might reasonably be expected from injuries of such a character. Mr. Coulson said that that was what he intended to convey by his statement. By prisoner's counsel.—He would not undertake to say that the deceased would not have died from the excitement alone, even if he had not received any blows. On re-examination, he said that the blows and the excitement together were, no doubt, the cause of death. A second medical witness said, that in his opinion, the deceased's death was the result of his excited state, and that delirium tremens was thereby occasioned, and not by the blows he received. He described the liver and kidneys of the deceased as presenting the appearance of those of a person addicted to drinking spirits or beer. It was contended that there was no distinct proof of the actual cause of death, or that the disease of which the deceased died had been brought on by the wounds, and the prisoner was acquitted of the felony. ('Med. Gaz.' vol. 38, p. 811.)

Death from surgical operations.—In the treatment of wounds, surgical operations are frequently resorted to, and a wounded person may die either during the performance of an operation, or from its consequences. A question may thence arise, whether the person who inflicted the wound shall be held responsible for the fatal result. The law of England regards a surgical operation as part of the treatment, and if undertaken *boná fide*, and performed with reasonable care and skill, the aggressor will be held responsible, whatever may be the result. The necessity for an operation, and the mode of performing it, will be left to the operator's judgment. As the defence may turn upon the operation having been performed unnecessarily, and in a bungling and unskilful

manner, it will be right for a practitioner, if possible, to defer it until he has had the advice and assistance of other practitioners. According to Lord Hale, if death takes place from an *unskilful operation*, performed for the cure of a wound, and not from the wound, the responsibility of the prisoner ceases; but this eminent lawyer does not appear to have considered that death may take place as a consequence of the most skilful operation required for the treatment of a wound, and yet be wholly independent of the wound itself.

Death is by no means an unusual result of severe operations, the secondary consequences under which the patient may die being very numerous, even when the case is most skilfully managed. Sometimes the patient will die on the table, although but little blood may have been lost. In a case related by Dr. Evans, of Galway, the patient, a healthy man, who had sustained a severe injury by an accident, died in a few moments after his leg had been amputated, although he had not lost more than four ounces of blood. Fear, pain, and sudden shock to the nervous system have caused death under these circumstances. The most common indirect causes of death after severe operations are secondary hæmorrhage, erysipelas, tetanus, delirium tremens, pyæmia, and hectic fever with gangrene of the stump. The late Mr. Travers observes that, 'a pre-existing disease of the liver, kidney, or testicles, though chronic, and in itself not alarming to the constitution, becomes a drag upon its elasticity, and stands in the way of recovery. Inspection of the body after death frequently explains the unfavourable result of operations that promise well, by discovering one or more organs in a state of chronic disease, which had not previously deranged the health in a degree sufficient to give notice of its existence, and which might, therefore, have remained quiet for years to come, had no extraordinary call been made upon the powers of the system.' ('On Constitutional Irritation,' pp. 45, 121, et seq.)

Should an operation be unnecessarily or unskilfully performed, the responsibility of an aggressor would, it is presumed, cease, if the death of a wounded party could be clearly traced to it. Thus, if in carelessly bleeding a wounded person, the brachial artery should be laid open ('Ann. d' Hyg.' 1834, 2, 445), or if, in performing amputation, a large artery be improperly secured, so that the patient in either case dies from the loss of blood, the prisoner could not be equitably held responsible; because it would be punishing him for an event depending on the unskilfulness of a medical practitioner. According to Plat B. (p. 572), a prisoner will be held responsible if the original wound was likely to produce death, although unskilfully treated. Supposing the bleeding or amputation to be performed with ordinary care or skill, and yet, in the one case inflammation of the veins, and in the other erysipelas, tetanus, gangrene, pyæmia, or fever should destroy life, the prisoner will be liable for the consequences. The practice of the law is strictly consistent with justice. Should the operation be considered to be *absolutely* required for the treatment of a dangerous wound, which, according to all probability, would prove mortal without it, should it be performed with ordinary skill, and still death ensue as a direct or indirect consequence, it is only just that the person who inflicted the injury should be held responsible for the result. It is presumed in these cases, that were the patient left to himself, he would, in all probability, die from the effects of the wound. If, therefore, a surgeon, knowing that an operation would give him a chance of saving life on such an occasion, did not perform it, it might be fairly contended in the defence that the deceased had died, not from the wound, but from the incompetency and neglect of his medical attendant. Hence it follows that if, during this necessary treatment unforeseen though not unusual causes cut short life, no exculpation should be admitted, if it went to attack the best-directed efforts made for the preservation of life. (See 'Ann. d'Hyg.' 1835, 1, 231.)

In another part of this work (p. 26), I have referred to the case of *Kelly*, who was tried for the murder of police-constable Talbot (*Reg.* v. *Kelly*, Dublin Commission Court, November 1871). The facts of this case, although made a subject of the most violent contention in a medical, legal, and political view, were really of a very simple kind. On July 12 deceased received a pistol-shot wound at the back of his neck, and died from the effects on July 16. The bullet fractured and splintered the atlas, wounding and crushing the soft parts of the neck, and leading to the formation of an abscess in this part. The actual cause of death was inflammation of the spinal cord and its membranes. Mr. Stokes, who attended the deceased, considered it necessary to enlarge the wound for the purpose of removing the bullet, which was then supposed to be lying within reach. In this operation a small artery (the occipital) was divided, but the quantity of blood lost was small; the bleeding was stopped by compression, and this bleeding had no influence in causing death. The defence was that the wound would not have proved fatal but for the bad surgical treatment; that the probing of the wound was unnecessary, and that it was unskilfully performed. There was the evidence of experts on both sides; but the facts proved, apart from the opinions expressed, could leave no reasonable doubt that Mr. Stokes had treated the case with *bona fides* and with competent skill. The prisoner was positively identified by deceased and others, and upon this evidence the jury returned a verdict of not guilty! (See 'Brit. Medical Journal,' Dec. 23, 1871, p. 716.)

The evidence of Mr. Tuffnell and others, surgical experts, showed that the probing operation performed on the deceased, which was made the subject of harsh and unjust comments by the counsel for the defence, was in strict accordance with the rules of surgery, and that the wound was of such a nature as from the first to be likely to prove mortal in spite of treatment. If any proof were required of the correctness of this opinion, it will be found in a public declaration, made subsequently to the trial, by nine eminent London surgeons, who one and all agreed 'that the bullet-wound in the neck of police-surgeon Talbot was the direct and sole cause of his death, and that no blame can be justly assigned to any of those by whom the wound was treated.' After this it is hardly necessary to comment on the legal amenities which characterized this trial. The operation of probing to remove a bullet, believed to be lodged in or near the neck-bone, was allowed to be described to the jury as 'reckless surgery,' and the operator denounced as one who ought to be placed in the dock on a charge of manslaughter! On the other hand, it is perfectly clear, that had not the probing been performed, and the bullet had been found post-mortem lodged in the spot, instead of being split and scattered, the same learned counsel, in defending the prisoner, would have described the surgeon as an ignorant bungler in his profession, who, by not trying to remove a bullet within an inch or two of the skin, had actually allowed his patient to die under his hands!

Professor Longmore, a high authority in military surgery, thus expresses himself on this case:—'It would have been acting wrongly had every effort not been made to extract the bullet from the situation in which it was supposed and reasonably inferred to be lodging. It is of immense importance that foreign bodies lodging in the walls of cavities should be got away if possible. No one acquainted with such subjects—at least no one who respects truth more than some other ulterior object—can really believe that the man's death in this case was due to anything else but the direct effect of the gun-shot wound which had been inflicted upon him.' ('Brit. Med. Jour.' 1871, Dec. 23, p. 717.)

In a notice of this remarkable case in the 'Medical Times and Gazette' for 1871 (vol. 2, p. 618), the editor, commenting on the altercations which

arose at the trial, as well as on the reckless charges of *mala fides* and unskilfulness allowed to be made by prisoner's counsel against surgeons who had employed all their skill to save a wounded man's life, says, truly enough, 'It needed a combination of all these things, with a verdict of "not guilty" to follow, to render the trial of Kelly one of the greatest legal scandals of modern times!'

The failure of justice in this case appears to have been chiefly owing to the fact that the jury were allowed to form their opinions on the surgical treatment pursued, whereas the rule of law is clear as to responsibility; and the only question which should have been submitted to them was, whether the prisoner was or was not the man who fired the pistol-shot. The English practice, as already quoted above, is, that if a man unlawfully inflicts a dangerous wound on another, and the wounded person, after being treated by qualified practitioners, acting with *bona fides*, and applying themselves with the best of their ability to the case, dies of the wound, the man inflicting it is really guilty of murder, even although an erroneous treatment of the case by the practitioner may have been the cause of death. In fact, under no other rule would a medical man be safe in dealing with a case of criminal wounding. If Kelly's case were taken as a precedent, no treatment should be adopted under these circumstances. The wound should be allowed to take its mortal course!

Medical responsibility in reference to the administration of chloroform.—In a large number of operations it is the general practice among surgeons to administer *chloroform vapour*, not only to allay pain but to prevent the exhaustion to the patient likely to arise from protracted surgical proceedings. In spite of care on the part of the operator, this vapour is liable to destroy life in an unexpected manner, and the patient may die either before the operation is commenced or during its performance. The facts may leave no doubt that the wounded person died from chloroform, and not from the wound or operation. On inspection of the body, the heart may be found in an unhealthy state—a fact which is usually considered sufficient to account for the fatal effects of chloroform vapour. In a case of this kind, what becomes of the responsibility of the person who inflicted the original wound? No decision, so far as I know, has ever been given on this point. Was the use of chloroform vapour in a professional view a *necessary* part of the treatment? Was it skilfully and *properly* administered? Could the diseased condition of the heart, which rendered the effects of the vapour more fatal than usual, have been detected by the operator, so as to show the impropriety of administering it in this case? These questions should receive satisfactory answers before the aggressor is rendered responsible for death under such peculiar circumstances. In *Absolom* v. *Statham* (Q. B. November 1867), an action was brought against a medical man for forcibly administering chloroform to the plaintiff against her will, and extracting six of her teeth; also for careless and unskilful treatment, whereby her health was injured. The medical evidence showed that the woman had consented to the operation, and that it had been properly performed; also that her health had sustained no injury by the chloroform or the operation, and that most of her symptoms were due to hysteria. Cockburn, C.J., in summing up the case, said, that the two charges or complaints were entirely distinct and different—one being for an assault, and the other for malpractice. The law was clear as to both. No surgeon had a right to perform any operation against the will of the patient, *so long as the patient preserved consciousness and will*; and if, therefore, the jury believed the plaintiff's story, then she was entitled to a verdict, although the amount of the damages would depend upon their impression as to the extent of the injury. Then, as to the other ground of complaint, the law was equally clear, that every medical practitioner was bound to bring a reasonable amount of skill and care to the per-

formance of the duty he undertook. The jury found for the defendant on both grounds. This shows the present state of the law in reference to the responsibility of medical men who undertake operations under chloroform.

Necessity for operations.—When an operation is rendered necessary for the maltreatment of an injury, the responsibility of an assailant, if the case proves fatal, ceases. In *Reg.* v. *Kingshott* (Lewes Summer Assizes, 1858), it was proved that prisoner and deceased fought, and that the prisoner bit the deceased severely on the thumb. According to the medical evidence the wound would, in all probability have healed of itself, or with some slight applications, but it seemed that the deceased went to a corn-leech in the neighbourhood, who had the reputation of performing wonderful cures, and he applied a powerful salve to the wound, the consequence of which was that severe inflammation ensued. The deceased then applied to a regular practitioner, who did all that was possible under the circumstances, but the whole arm was in such a condition that it was deemed advisable to remove him to the hospital, where his arm was amputated, and he died from the effects of the operation. For the defence it was contended that the prisoner ought not to be convicted of causing the death of the deceased, inasmuch as it was proved that the original injury was of a slight character, and not at all calculated to produce a fatal result, and that the deceased had conduced to his own death by suffering himself to be treated by an ignorant and unskilful person. The learned judge held that the charge of manslaughter could not be supported upon the evidence, and he therefore directed the jury to acquit the prisoner.

By an operation being *absolutely required*, are we to understand that it should be necessary to preserve life, *i.e.* that the wound would probably prove fatal without it? Bleeding and cupping may be necessary as part of the treatment of a wounded person; but unless it could be sworn that this treatment was required, in the judgment of the surgeon, for the *preservation of life* from the injury inflicted, it is doubtful whether, in the event of death occurring from these simple operations, the assailant would be held responsible for the fatal result. In 1827 two persons were tried in Edinburgh, for capitally assaulting another, by throwing sulphuric acid over him. (*Rex* v. *Macmillan.*) The death of the deceased was clearly due to inflammation of a vein and concomitant fever, following the operation of bleeding, which was considered necessary in the treatment of the case. It did not appear that this bleeding was absolutely necessary for the preservation of life, but merely for the prevention of severe ophthalmia. The charge of murder was therefore abandoned by the Lord Advocate, this question of responsibility for the fatal result being considered to involve too nice a point to ensure conviction. ('Ed. Med. and Surg. Jour.' April 1829, 230.)

From cases hitherto decided, it would appear that the law regards three circumstances in death following surgical operations:—1st, the necessity for the operation itself; 2nd, the competency of the operator; and 3rd, the fact that the wound is dangerous and would be likely to prove mortal without it. A few recent cases will serve to illustrate the view taken by our judges of this most important question, which may involve, not merely the reputation of a surgeon, but the life of an accused party. The first which requires notice is that of the *King* v. *Quain* and others. (Limerick Spring Assizes, 1836.) Dillon (the deceased) received a comminuted fracture of the leg, produced by blows with a stick. He was taken to an hospital, and it was proposed to amputate the injured leg, but deceased would not consent. After some days, symptoms of approaching mortification made their appearance. All the surgeons agreed that the only chance of saving life was the immediate removal of the leg. The deceased then gave his assent, and the operation was skilfully performed. The injury was inflicted on the 10th of October; the operation was

not performed until the 9th of November, and Dillon died on the 19th (*i.e.* ten days after the operation) from tetanus, which, it was admitted, had resulted from the amputation, and not from the wounds inflicted by the prisoners. For the prisoners it was argued that the deceased did not die of the wounds as alleged in the indictment, but from the medical treatment. On the other side, it was contended that the injury to the leg was *causa causans*, as the recovery of the patient would have been utterly hopeless without amputation, and the counsel properly asked, 'Is he (a wounded person) to lose the benefit of medical skill, lest death might ensue from a necessary although dangerous operation? How unfair would such a course be to the accused, as well as unjustifiable towards the wounded person! If neglected, his death is certain; if subjected to the treatment, his recovery probable.' The learned judge held (the amputation being considered a necessary part of the patient's treatment) that the death of Dillon, although not proximately, was actually caused by fracture of the leg, and so directed the jury, who returned a verdict of guilty. The disputed point was reserved, and argued before the twelve judges. In addition to the arguments in support of the conviction above given, it was represented as being laid down in the books, that if one give a wound to another, who neglects the cure, or is disorderly, and doth not keep that rule which a wounded man should do, yet if he die it is murder or manslaughter; because if the wounds had not been given the man had not died. (See case *Reg.* v. *Thomas*, *ante*, pp. 563, 574.) The exceptional cases are where death results from the medical treatment; but these are reducible to two classes:—1. When the wound is *not* in itself *mortal*, and the treatment causes the death. (*Rex* v. *Macmillan*, p. 587.) And 2ndly, when the death is clearly caused by the *treatment*, either by reason of its being *unskilful*, or not being necessary to save life in the opinion of skilful persons. (*Rex* v. *Macewan*, *ante*, p. 572.) The judges ruled the point against the prisoner, with the exception of one dissentient. In this case, the three conditions requisite for responsibility clearly existed: the operation was absolutely necessary to save life—there could be no question as to the competency of the operator—and the wound would, according to all surgical experience, have proved fatal without it. The wounded person may, as in the preceding case, have refused to submit to an operation when in the judgment of a medical man it was necessary to save life, or he may have submitted to it when too late. In *Reg.* v. *Draper* (C. C. C. August 1872), involving a charge of manslaughter, this question again presented itself. The prisoner, while carelessly driving a waggon, knocked down the deceased, and a wheel passed over his left arm just above the elbow. Deceased was taken to the Royal Free Hospital, when it was proposed at once to amputate the arm, but deceased, after consulting with his friends, refused to submit to the operation. The arm was then dressed and put into splints, and the man was told that his life would be endangered if he did not permit his arm to be amputated. A week later he consented to the operation being performed. The arm was removed, but he died of pyæmia, one of the secondary consequences of the operation. In the opinion of the medical officers of the hospital the man's life would have been saved if he had allowed immediate amputation. Quain, J., told the jury to put out of their minds the question whether death had ensued from the determination of the deceased not to have his arm amputated, as that was a matter of law, upon which, if necessary, he would reserve a case. The question for them to consider was whether, owing to the negligence of the prisoner, the deceased sustained the injury which led to his death. The jury found the prisoner guilty.

In *Reg.* v. *Perrall* (Taunton Lent Assizes, 1847), it was proved that the prisoner had thrown a stone at the deceased, and caused a fracture of the skull. On a consultation, the medical practitioner performed the operation of tre-

phining. The deceased apparently rallied, but he subsequently became worse, and died on the 19th day after the injury; and it was found that there was an abscess in the brain. The medical witnesses referred death to the blow, but admitted that it might have been accelerated by the operation. It was contended in the defence, that although the injury without the operation might have proved mortal, yet that the deceased had really died from the medical treatment. Cresswell, J., observed, that it was admitted the wound was mortal, and that the deceased might have died in a month, but that he had died in less than a week in consequence of the operation. The wound being mortal, if that which was done by the surgeon was what he considered right to be adopted, there would be no question raised upon this point. The prisoners were convicted. In this case, there can be no doubt as to the propriety of the decision. Competency for forming a judgment, or for undertaking an operation, does not imply, on these occasions, the first-rate abilities of a surgeon of high standing, but that average skill and experience which every legally qualified practitioner is presumed by law to possess; and although, from numerous extraordinary recoveries, it is difficult to say whether a man would or would not have died under a particular injury without an operation, yet here, again, the law would allow a free exercise of judgment, and would not act upon extraordinary exceptions. In a similar case, which occurred a few years since in Germany, an attempt was actually made to exculpate the aggressor on the ground that the wounded man had died from the neglect of the surgeon in not performing the operation of trephining, and that he would have recovered had this been resorted to! ('Brit. and For. Med. Rev.' 13, 259.)

Operations under a mistaken opinion.—It may happen that the wound is not mortal, and that, although skilfully performed, the operation was *not* necessary to save life; in other words, the wounded person may have died from the immediate results of a serious operation, performed under a mistaken view of the case. It is well known to surgeons that a cancerous tumour has been mistaken for aneurism, an artery has been secured, and death has followed. A case occurred in Dublin in 1844, in which the carotid artery was tied; and another in London in 1845, in which the operation was performed on the common iliac artery for supposed aneurisms: in both of these instances, the patients sank, and after death the tumours were proved not to have been aneurismal. The operations were not necessary, they proved fatal, and they had been performed under a mistake. In a case reported by Mr. Syme the carotid artery was tied, and the patient died in a few days from loss of blood. After death it was found that the tumour was not an aneurism, but a cyst containing a thin fluid. ('Dub. Med. Press,' Dec. 22, 1847, p. 302.) Let us take the case that a man labouring under a slight aneurismal dilatation of a large artery receives a blow on the part; the tumour gradually increases, and is mistaken for an abscess by three or four surgeons, whose professional standing would prevent their general competency from being questioned. Under a wrong diagnosis it is opened, and the patient dies on the spot: it would, in such a case, be unjust to make the aggressor liable; for, even admitting that the aneurism resulted from the blow, and that competent surgeons had acted with *bona fides*, the treatment would be unskilful, and the case would fall under the rule laid down by Lord Hale (*ante*, p. 584). The real facts, however, may not transpire until after the death of the wounded person; and it may then be alleged by a prisoner's counsel that the operation was not necessary to save life, and that the wounded man might have recovered without it. This question derives especial interest from the Gosport duel case (June 1845), in which a Lieutenant *Seton* was killed. (*Reg.* v. *Pym*, Hants Lent Assizes, 1846.) A tumour formed in the course of the pistol-shot wound received by the deceased at the lower part of the abdomen; and this was supposed by the late Mr. Liston and two other

surgeons in attendance on the deceased, to be an aneurismal enlargement from a wound in or injury to the femoral artery, for which it was considered necessary to tie the external iliac artery. The patient died from peritoneal inflammation following this serious operation; and on inspection, it was found that the tumour (the supposed aneurism) was formed by a mass of coagulated blood poured out, not from the femoral artery, but from one of its superficial and anomalous branches, which was divided about an inch below Poupart's ligament, and an inch from the main body of the artery. There was some difference of opinion about the necessity for the operation, both as to the time selected for its performance, and as to its being absolutely requisite for the preservation of life. One witness thought that it was absolutely necessary to perform it at the time; while another thought it absolutely necessary, under the circumstances, to save life. In his evidence at the trial, Mr. Liston stated that 'the tying of the iliac artery was necessary. The danger of allowing the false aneurism to go on would be violent bleeding, which might have proved instantly fatal. 'In my judgment no other operation would have been prudent than that of tying the iliac artery.' Counsel for the prisoners proposed to cross-examine the medical witnesses in order to show that the wound was not dangerous to life, and the operation not absolutely necessary; but Erle, J. interposed.—I presume you propose to call counter-evidence, and impeach the propriety of the operation, but I am clearly of opinion that if a dangerous wound is given, and the best advice is taken, and under that advice an operation is performed, which is the *immediate* cause of death, the party giving the wound is criminally responsible. Cockburn.—I proposed to show that the opinion formed by the medical men was grounded upon erroneous premises, and that no operation was necessary at all, or, at least, that an easier and much less dangerous operation might and ought to have been adopted. I may therefore cross-examine the witnesses as to the grounds of their opinion. I shall submit that a person is not criminally responsible where the death is caused by consequences which are not physically the consequences of the wound, but can only be connected with the first wound by moral reasonings, as here that which occasioned death was the operation which supervened upon the wound because the medical men thought it necessary. The point has never been solemnly decided in this country. The cause of death is a question for the jury. Erle J.—I am clearly of opinion, and so is my brother Rolfe, that where a wound is given which, in the opinion of competent medical advisers, is dangerous, and the treatment which they *bonâ fide* adopt is the immediate cause of death, the party who inflicted the wound is criminally responsible, and of course those who aided and abetted him in it. I so rule on the present occasion; but it may be taken, for the purpose of future consideration, that it having been proved that there was a gunshot wound, and a pulsating tumour arising therefrom, which, in the *bonâ fide* opinion of competent medical men, was dangerous to life, and that they considered a certain operation necessary, which was skilfully performed, and was the immediate and proximate cause of death,—the counsel for the prisoner tendered evidence to show this opinion was wrong, and that the wound would not inevitably have caused death, and that by other treatment the operation might have been avoided, and was therefore unnecessary. I will reserve this point for the consideration of the judges, although, as I have already stated, I have no doubt upon the subject. To admit this evidence would be to raise a collateral issue in every case as to the degree of skill which the medical men possessed.

The point was reserved, but as the prisoner was acquitted of the charge, the opinion of the judges was not taken. ('Law Times,' March 21, 1846, p. 500.) The question was subsequently raised at the trial of the principal in the duel (*Reg.* v. *Hawkey*, Hants Summer Ass., 1846), but Platt B. decided in accord-

ance with the opinion of Erle J. and Rolfe B. The prisoner was acquitted. ('Law Times,' July 25, 1846, p. 370.) Although in this case no question could arise as to the competency of the surgeons, or the skill with which the operation was performed, yet the principle involved in the decision stops all inquiry respecting the necessity of an operation, leaving this to the *bonâ fide* judgment of the operator—and it leaves undecided, as in *Macmillan's* case (*ante*, p. 587) the important question whether the operation was or was not necessary to save life. Such a rule, if rigorously carried out, would undoubtedly shelter many surgical mistakes; and although in this instance the best advice was taken, yet as the degree of skill in the operator is not an ingredient in the prisoner's responsibility (*ante*, p. 584), the decision could hardly be justified upon this ground. Had the operation been performed by the usual attendant of the deceased, it is to be presumed that the result would have been the same; hence it appears, that although an operation might be unnecessarily performed and cause death, yet the prisoner would be held responsible for the result. A man has his leg fractured by a blow; a surgeon, acting on a *bonâ fide* opinion of danger to life, may amputate the leg; the wounded person dies from a sloughing of the stump, pyæmia, or some other secondary cause; and an investigation of the facts may show that amputation was not necessary, and that the patient might have recovered without it. Is the person who inflicts the blow to be made responsible for the mistake? Is no inquiry to be instituted respecting the propriety or necessity of an operation always more or less dangerous to life? It is obviously impossible that anything can be known to the Court extra-judicially respecting competency, necessity, or skill in operating on these occasions, until all the facts have been laid before the jury. But to take what may appear to be a near parallel to *Seton's* case:—A man during a quarrel receives a severe blow in the groin from his adversary; this is followed by a pulsating tumour, which is pronounced to be an aneurism of a femoral artery by three competent surgeons out of five (two dissentient), and the dangerous operation of tying the external iliac artery is performed. The patient dies in about thirty-six hours from peritonitis, as a direct result of the operation; and after death, it is found that the tumour was not an aneurism, and had no connection with the femoral artery—that the tying of the artery was not really required in the opinion of competent surgeons, and that had the case been left to itself, the patient might have recovered. Is the person who struck the blow to be made responsible for the fatal result? Upon the ruling in *Pym's* case, he would be, for provided the operation was performed with *bona fides*, the question as to necessity could not be raised. The relative degree of skill possessed by medical men does not, therefore, become a question for a jury in a criminal case; although in civil cases, as in actions for malapraxis, the whole of the medical facts are invariably submitted to their judgment. This difference can only be justified by the assumption that a man who inflicts a wound must take all the consequences—good or bad. No operation would have been required but for the injury, and the prisoner ought not to escape on account of want of skill in a surgeon, or of a mistake made by a skilful operator. It was decided in the case of *Rex* v. *Quain* and *Reg.* v. *Pym*, that although the indictment alleged that the deceased died of the wound, while in fact he died from the results of an operation, yet it was good in point of law.

A case which was the subject of a trial at the Central Criminal Court (*Reg.* v. *Fueling*, 1872), involved some of the points here raised. The prisoner severely kicked the deceased on the right knee. He was able to walk home with much difficulty. Disease set in, and about ten months after the violence, amputation of the leg was performed. Ulceration of the stump took place, and the deceased died from secondary hæmorrhage. There was much disease about the leg. It was contended that notwithstanding the long period which had elapsed, the deceased

had died from the unlawful act of the prisoner. For the defence it was suggested that deceased had died from an operation which was not necessary to the treatment. In addressing the jury, Channel B. said, if a man attacked another and certain results ensued, in the course of which the qualified and competent medical adviser who might be called in took in his discretion a step the termination of which was unsuccessful, and which, perhaps, in the exercise of superior skill would not have been adopted, that termination would not save the man by whom the injury was inflicted from the consequences of his act. He added that in this case they had nothing to do with the question whether or not the offender contemplated the result of his act. The prisoner was acquitted. The case of *Thouret Noroy* shows that the French law also acts upon the principles here laid down. This gentleman, who was a physician, performed the operation of bleeding on a patient. It is alleged, but upon evidence of a very questionable character, that he punctured the brachial artery in opening the vein. Three months afterwards the patient applied to another practitioner, an officier de santé, one of the lowest grade in France, who declared that an aneurismal tumour existed at the spot where the man was bled. He advised tying the brachial artery, and he subsequently performed the operation; but mortification of the limb ensued, and the patient was afterwards compelled to undergo amputation. As he was a labouring man, the loss of his arm was so serious, that he was advised by his friends to seek reparation in damages from the physician who first bled him. The trial came on in a Provincial Court, and heavy damages were awarded against the physician. An appeal was made to a Superior Court, but the sentence was confirmed and the damages were increased. Of this case it may be fairly said, *summum jus summa injuria*. Admitting that the defendant had been guilty of gross carelessness and criminal inattention in puncturing the brachial artery, there was fair ground to question whether the subsequent operation of tying the artery was a necessary or proper mode of treatment under the circumstances. There is no doubt that the officier de santé acted with *bona fides*, and took this view; but it seems to have been a case demanding an inquiry into the circumstances which led him to operate; for the operation may have been unnecessary and unjustifiable on the principles of good surgery. It is highly probable that the patient sustained a greater amount of damage at the hands of the surgeon who tied the artery, than of the physician who punctured it.

Fatal diseases following operations.—When a wounded person is taken to an hospital in which gangrene or erysipelas is diffusing itself by infectious propagation, and he is attacked by one of these diseases before or after the performance of an operation, and dies, a prisoner may be held responsible for the fatal result. It might be contended that the transportation of the wounded man to such a locality was not absolutely necessary to the preservation of his life, and that he would not then have died, but for the accidental presence of an infectious disease. Cases of this kind cannot be easily determined by general rules, but the question has already been raised before a legal tribunal, in a trial which took place at the Maidstone Lent Assizes, 1839. (*The Queen* v. *Connel and others*.) The deceased was assaulted by a number of soldiers, and received two blows on his head with a stick. The wound was not of any great extent, and the deceased did not appear to suffer much from it. Two days afterwards, he was attacked by *erysipelas* in the head and face, and he died in about a week. On inspection, there was no appearance of organic disease. The surgeon referred death to erysipelas, which was prevalent in the hospital at the time the deceased was brought in. The man would probably have recovered but for the attack of erysipelas, and he did not think that he would have been attacked by this disease but for the wound. Erysipelas was an infectious disease, and a common consequence of wounds of the head. Upon this evidence the prisoners were convicted. In *Reg.* v. *Norris*

(Wells Summer Assizes, 1860), the deceased, a gamekeeper, died from tetanus following amputation of the leg, rendered necessary by a gun-shot wound inflicted by the prisoner. No attempt was made to deny the responsibility of the prisoner for the fatal result.

In addition to erysipelas and tetanus, there is another cause of death which is liable to follow personal injuries and operations, namely *pyæmia*, or the introduction of pus into the blood by absorption or by the mouths of divided blood-vessels. The purulent matter appears to act as a poison, and one of its marked effects is to coagulate the blood either in the large vessels or in the capillaries. According to Dr. Wilk's observations, pyæmia is seldom observed after superficial injuries during the process of healing, or after wounds resulting from simple operations, but it occurs frequently when a bone is involved either in the injury or as the result of an operation. Inflammation of the cellular membrane surrounding bone is a condition highly favourable to its occurrence. It has been stated that the cause of death in one half of the cases of amputation is pyæmia. (See a paper on this subject by Dr. Wilks, 'Guy's Hospital Reports,' 1861, p. 119.) In *Reg.* v. *Maynard* (Maidstone Lent Assizes, 1862), involving a charge of manslaughter by wounding, the medical evidence was to the effect that death was caused by pyæmia. Extensive suppuration had taken place, abscesses had formed in the cellular membrane, and pus had been absorbed to a degree to prove fatal. The medical witness must remember that pyæmia may arise from causes totally irrespective of wounds or personal injuries. (Cases by Dr. Habershon, 'Guy's Hospital Reports,' 1859, p. 179.)

Questions relative to responsibility in death following operations would come more frequently before Courts of law, were it not that the cases are stopped in the Coroners' courts by verdicts of accidental death. (See 'Med. Gaz.' vol. 19, p. 157.) It unfortunately happens that on these occasions there is great difference of opinion among medical witnesses respecting the connection of the disease with the death, and, indeed, the necessity for the operation itself. The evidence of opinion in favour of the prosecution is sometimes exactly balanced by that urged in the defence, and under these circumstances the only course open to the Court is to direct an acquittal. Differences of opinion upon these subjects among members of the profession tend to convey to the public the impression that there are no fixed principles upon which medical opinions are based, and, consequently, that it would be dangerous to act upon them. Thus it is that we are accustomed to hear of a medical prosecution and a medical defence, as if the whole duty of a medical jurist consisted in his making the best of a case, on the side for which he happens to be engaged—adopting the legal rule of suppressing those points which are against him, and giving an undue prominence to others which may be in his favour. This is an unfortunate condition of things, for which at present there appears to be no other remedy than that of appointing a Medical Board of competent persons, to act as assessors, to whom such questions should be referred, in the same manner as questions relative to navigation are referred by the Admiralty Court to a Board formed of members of the Trinity House, professionally acquainted with the matters in dispute.

Medical Responsibility in Operations. Malapraxis.—This is a very wide subject, but it can here be only glanced at in a few of its leading features. It was held by Lord Ellenborough, that if a person acting in a medical capacity be guilty of misconduct arising either from gross ignorance or criminal inattention, by which a patient dies, he is guilty of manslaughter. Faults, such as omissions, or errors in judgment, to which all are liable, are not visited with this amount of criminality. The same rule applies to the licensed as to the unlicensed practitioner; but it would appear, from the charge of Williams J.

(Winchester Spring Ass. 1847), that a degree of unskilfulness which might lead to the conviction of a licensed, would justify the acquittal of an unlicensed person. This was in the case of a midwife, æt. 72, alleged to have caused the death of a woman on whom she had been called to attend. 'The charge,' said the learned judge, 'appeared to be, that by want of skill or attention to her duties, she had caused the death of the woman upon whom she was attending. In order to constitute this offence, it must be shown that the party was guilty of criminal misconduct, either arising from gross ignorance, or want of skill, or gross inattention. With respect to the degree of want of skill, he must say, that it was not to be expected that a midwife who was called in to attend a person in the humble class of the deceased, a soldier's wife, should exhibit what a medical practitioner would call competent skill. It was enough if she applied that humble skill which, in ordinary cases, would lead to a safe delivery. She was not bound to have skill sufficient to meet peculiar and extraordinary exigencies, although in the case of a regular medical man such skill might be required. The class of this humble practitioner was absolutely necessary for the poorer classes, and, although on the one hand it was fit the law should protect the patient by punishment for gross want of skill, yet he thought there would be much to be lamented if it was applied with such severity as to render a party not possessing skill of this kind, liable to punishment for manslaughter.'

Charges of manslaughter have frequently been brought against medical practitioners in cases of midwifery. In some instances gross mismanagement has been proved; the uterus, and even parts of the viscera, have been torn away, and in such cases convictions have very properly followed. It is well known, however, that much difference of opinion exists among the most eminent practitioners of midwifery respecting the treatment to be pursued in certain cases of difficulty, as where the after-birth presents (placenta prævia). There are eminent accoucheurs who advise in this ease entirely opposite modes of practice, and who look upon that pursued by the other as of the most dangerous kind. The case of *Reg.* v. *Dickinson* (Stafford Lent Assizes, 1846) is in this respect of interest. A medical practitioner was charged with having caused the death of the deceased in her confinement. This appears to have been a case of placenta prævia: the placenta was removed, but the female sank under the bleeding which followed. Platt B., after consulting several medical works charged the jury that if, in a particular case, there are two modes of treatment respecting the adoption of either of which men of learning are equally divided then no man can be said to be 'grossly ignorant' in adopting a course which has received the approbation of eminent writers, and which his own judgment sanctions and approves. The accused was immediately acquitted. ('Med. Gaz.' vol. 37, p. 875.) When death is not a result of the medical treatment, an action for damages may be brought against the practitioner for *malapraxis*. From the evidence given on some of these occasions, it appears that an action of this kind is occasionally resorted to as a very convenient way of settling a long account.

It has been a question whether slight deviations from the ordinary mode of performing operations should involve a practitioner in a charge of malapraxis. I am not aware that this question has been raised in England: but a remarkable instance occurred in the United States a few years since, in which an action was brought and damages were recovered against a medical man for alleged negligence in vaccinating a young woman (case of *H. L. Landon*). Some inflammation of the skin followed the operation, which, it was alleged, was performed nearer to the elbow-joint than was usual. The plaintiff soon recovered from the effects. The most singular feature of this case was the ruling of the judge he is reported to have said—'In performing the operation of vaccination or

innoculation, the physician is liable for all consequences if he neglects the usual precautions, or fails to insert the virus in that part of the arm *usually selected* for the purpose; notwithstanding many other parts of the body might be proved to be equally proper and even more suitable locations!' If this be law, it is a very singular specimen of transatlantic jurisprudence. It might as well be ruled that a limb should always be taken off with a particular kind of knife, and the bone sawn through with a *normal* saw; and in case of neglect of this rule, that the operator should be made responsible for the results!

The case of *Gibbs* v. *Tunaley*, tried at the Norfolk Lent Assizes, 1845, is interesting in relation to this subject. An action was brought against the defendant, a surgeon, for alleged negligence and want of skill in treating an injury to the foot, which the plaintiff had sustained. Mortification took place, and amputation was necessarily performed. The plaintiff and his witnesses alleged that the mortification was caused by tight bandaging, but the defendant brought good medical evidence to show that it was most probably due to the extensive violence from the accident (a railway accident), and there is but little doubt that this was the correct view of the case. Mr. Baron Parke observed in his charge, that they (the jury) were not to expect from a country practitioner the same amount of eminent skill to be met with in large towns; but they had a right to expect from him the usual and ordinary amount of skill, care, and attention which it was only reasonable to suppose he would possess; and if, in the discharge of his duty, he applied his professional skill and knowledge to the best of his ability, then, however unfortunate the termination of the case, he was not to be visited with an action to mulct him for damages. Such a step would be most unjust, and have an injurious tendency, as it would check that independence of action so necessary for medical men to possess. Damages one farthing!

In the case of *Baker* v. *Lowe* (Queen's Bench, Feb. 1845), a medical man brought an action against the defendant for the amount of his bill, and the defence was that he had been unskilfully and improperly treated. The defendant had been attacked with senile gangrene in the toe; the toe was removed, but the disease involved the foot, and amputation was again performed. The plaintiff had adopted a stimulating plan of treatment in the first instance, which it was alleged was improper. The medical evidence was very conflicting, and the only inference which can be deduced from it is, that in some cases a stimulating, and in others an antiphlogistic, treatment is admissible. The plaintiff brought two experienced witnesses who approved of his treatment, and the jury returned a verdict for the greater part of the amount claimed. (See 'Med. Gaz.' vol. 36, p. 126.) When there is such a division of opinion among men of equal experience, a practitioner has a right to expect that a verdict will be returned in his favour; since it is not to be supposed that in order to recover payment for a bill, or to answer a charge of unskilfulness, a man's practice should receive the unanimous approval of the *whole* of his professional brethren, especially in cases in which there is an acknowledged difference of opinion respecting the treatment. On this showing, a man would never be able to recover his charges for the treatment of a case of severe burn or scald; since some practitioners consider it malapraxis to adopt the stimulating, while others equally regard it as malapraxis to adopt the cooling plan of treatment! All that appears to be expected is a reasonable accordance in treatment with received professional doctrines.

CHAPTER 44.

CICATRIZATION OF WOUNDS—EVIDENCE FROM CICATRICES—CHANGES IN AN INCISED WOUND—IS A CICATRIX ALWAYS A CONSEQUENCE OF A WOUND?—ARE CICATRICES WHEN ONCE FORMED INDELIBLE?—CHARACTERS OF CICATRICES—IDENTITY PROVED OR DISPROVED BY CICATRICES—COLOURED CICATRICES—TATTOO MARKS—THE TICHBORNE CASE—CICATRICES FROM DISEASE DISTINGUISHED FROM THOSE OF WOUNDS—WHEN WAS THE WOUND INFLICTED?—GANGRENE AND PUTREFACTION—CHANGES IN CONTUSIONS—HOW LONG DID THE DECEASED SURVIVE THE WOUND?

Cicatrization of wounds.—The period of time at which a particular wound was inflicted may become a medico-legal question, both in relation to the living and the dead. The identity of a person, and the correctness of a statement made by an accused party, may be sometimes determined by an examination of a wound or its cicatrix. So, if a dead body be found with marks of violence upon it, and evidence adduced that the deceased was maltreated at some particular period before his death, it will be necessary for a practitioner to state whether, from the appearance of the injuries, they could or could not have been inflicted at or about the time assigned. A case was tried at the Taunton Spring Assizes, 1841 (*The Queen* v. *Raynon*), wherein evidence of this kind served to disprove the statement made by the accused. He was charged with maliciously cutting and wounding the prosecutrix. There was a cut upon his thumb, which he accounted for by saying it was from an accident that had occurred three weeks before. The medical witness declared, on examining it, that it could not have been done more than two or three days, which brought the period of its infliction to about the time of the murderous assault. This with other circumstances led to his conviction.

An *incised* wound inflicted on the living body gradually heals by adhesion, when no circumstances interfere to prevent the union of the edges. For eight or ten hours the edges remain bloody—they then begin to swell, showing the access of inflammation. If the parts are not kept well in contact, a secretion of a serous liquid is poured out for about thirty-six or forty eight hours. On the third day this secretion acquires a purulent character. On the fourth and fifth days, suppuration is fully established, and it lasts five, six, or eight days. A fibrous layer, which is at first soft and easily broken down, then makes its appearance between the edges of the wound: this causes them gradually to unite, and thus is produced what is termed a *cicatrix*. Cicatrization is complete about the twelfth or fifteenth day if the wound is simple, of little depth and width, and affecting only parts endowed with great vitality. The length of time required for these changes to ensue will depend—1. On the situation of the wound; wounds on the legs are longer in healing than those on the upper part of the body. If a wound is situated near a joint, so that the edges are continually separated by the motion of the parts, cicatrization is retarded. 2. On the extent; a deep or wide wound is long in undergoing cicatrization. Wounds involving many and different structures are also longer in healing than those simply affecting skin and muscles. 3. On the age and health of the wounded person; the process of cicatrization is slow in old persons as well as in those who are diseased and infirm. In an incised wound the cicatrix is generally straight and regular; but it is semilunar if the cut is oblique. It is soft, red, and tender if cicatrization is recent; it is hard, white, and firm if of long standing. On compressing the skin around an old cicatrix, its situation and form are well marked by the blood not readily entering into it on removing

the pressure. It has been said that the cicatrices of incised wounds are rectilinear, but this is not always the case; in general, they are more or less elliptical, being wider in the centre than at the two ends—this appears to be due principally to the elasticity of the skin and the convexity of the subjacent parts; thus it is well known that in every wound on the living body, the edges are more separated in the centre than at the ends, and this physical condition influences the process of cicatrization. When the wound is in a hollow surface, or over a part where the skin is not stretched, as in the arm-pit or groin, then the cicatrix may be rectilinear, or of equal width throughout. If there is any loss of substance in an incised wound, or if the wound is lacerated or contused, the cicatrix will be irregular, and the healing will proceed by granulation. The process might then occupy five, six, or eight weeks, according to circumstances. When healed, the cicatrix would be white, and if there had been a loss of substance it would be depressed and present a puckered appearance; the surface of the skin would be uneven. (See an essay on this subject by Dr. Krugelstein, Henke's 'Zeitschrift der S.A.' 1844, b. 2, s. 75.)

Is a cicatrix always a consequence of a wound?—Assuming that the term wound implies a breach of continuity affecting the substance of the true skin (cutis), a cicatrix is always produced in the process of healing. Slight punctures or incisions with a lancet, and even leech-bites, affecting only the surface of the cutis, may leave no trace after a few weeks or months. In an even cut made by a very sharp instrument, especially if it is in the direction of the fibres of subjacent muscles and the parts are kept in close contact, the cicatrix is even, linear, and sometimes so small as to be scarcely perceptible; and if the skin is white, it may be easily overlooked. Wounds of this kind are not, however, commonly the subject of medico-legal inquiry. If, on examining a part, where at some previous time a stab, cut, or burn involving the cutis, is alleged to have been inflicted, we find no mark or cicatrix, it is fair to assume that the allegation is false, and that no wound has been inflicted, making due allowance for the fact that mere abrasions of the cuticle, or very slight punctures and incisions, often heal without leaving any well-marked cicatrices.

Is a cicatrix, when once formed, ever removed or so altered by time as to be no longer recognizable?—This is a question which sometimes presents itself to a medical jurist both in civil and criminal proceedings. When a cicatrix has been produced by the healing of a wound involving a loss of substance in the cutis or true skin, it is permanent. In wounds involving the whole substance of the skin, the cicatrix which is once formed does not disappear, although it may undergo some changes and become less distinct in after-life. Wounds which heal by suppuration and granulation generally leave behind them cicatrices which remain for life. The marks arising from the pustules of vaccination, small-pox, herpes zoster, and those produced by setons and issues, leave cicatrices easily recognizable at any period. In an early stage a cicatrix is soft and redder than the surrounding skin, but after some months or years it becomes white, hard, smooth, and shining. The time required for these changes to take place cannot be defined. In one person they may take place in a few months, and in another only after some years. The tissue of which an old cicatrix is formed, is different from that of the skin; it is harder, contains less blood, and is destitute of any coloured pigment, so that its whiteness, which is remarkable on the cicatrized skin of a negro, is retained through life. If any cicatrices were easily obliterated, it would be those which are even and regular—the results of incised wounds by sharp instruments; but I have observed that small cicatrices of this kind have certainly retained their characters unchanged in one instance for twenty, and in another for twenty-five years. According to the observations of Dupuytren and Delpech, the substance of a cicatrix is not converted into true skin—it never acquires a rete mucosum, *i.e.* the mem-

brane which gives colour to the skin. Although this is generally true of incised and punctured wounds, yet contused and lacerated wounds on the legs of persons advanced in life, frequently present a brown discolouration—from the deposit of a brown pigment. In the cicatrices of lacerated and contused wounds, the form of the weapon with which the wound was inflicted is sometimes indicated. It is not, however, easy to distinguish the cicatrix of a stab of old date from that produced by a pistol-bullet fired from a distance. In both cases the edges may be rounded and irregular, and the cicatrix puckered, unless the stab has been produced by a broad-bladed weapon. If no mark of cutting can be perceived within a few months of the period at which a severe wound is alleged to have been inflicted, it is reasonable to infer that there has been some mistake, or that the circumstances have been greatly exaggerated.

A case in which this question was raised, was referred to me under the following circumstances. (The *Queen* v. *Henry Reed* and *Elizabeth Donelan*, Chelmsford Spring Assizes, 1842.) The medical evidence was to the effect, that 'there was a wound on the nose of the prosecutrix, apparently inflicted by some sharp instrument, and the bridge of the nose was broken down. The weapon had entered half an inch, and had caused profuse bleeding. The wound was so deep that if it had entered a little higher up in the eye, it might have caused death.' In the defence it was urged that no weapon had been used; and that although the male prisoner had struck the prosecutrix a blow, the female prisoner had taken no share in the assault. It does not appear that any medical evidence was called to show in what state the prosecutrix was at the time of the trial. It was assumed that a weapon must have been used, and the prisoners were convicted, the one of stabbing and the other of aiding and abetting. About six months after the alleged stabbing, and some weeks after the prisoners had been convicted and sentenced to punishment, the face of the prosecutrix was examined by two surgeons (one of them a practitioner of twenty-eight years' standing), and they both deposed that there was no mark of a cicatrix from a stab, of fracture of the nose, or of any personal injury whatever. Other surgeons were requested to examine the face of the prosecutrix, but this she declined to permit; and as there was no power to compel her, the medical facts of the case were referred to Professor Quain, Mr. Guthrie, Mr. Key, and myself. The evidence of the surgeons at the trial was laid before us, with the statements of the two surgeons who subsequently examined the prosecutrix. We all agreed that if such a wound as that described in the medical evidence had been inflicted, there would have been a visible scar and a ridge or prominence indicative of the situation where the bridge of the nose was stated to have been broken; and as no such marks could be perceived by two well-informed surgeons, we considered it improbable either that such a wound as that described could have been inflicted, or that a weapon could have been used in the assault. The medical question really to be decided was—Could all traces of the cicatrix of such a wound as that above described be effaced in a period of six months, or even during the life of a person? Either the wound must have been misdescribed, or some marks of its past existence in the form of a cicatrix would unquestionably have been found.

Characters of cicatrices. Their age or date.—It is important to observe that all cicatrices are of smaller size than the original wound, for there is a contraction of the skin during the process of healing. This is especially noticed with regard to the cicatrix of a *stab*, which is frequently of a triangular form. A recent stab, owing to the elasticity of the skin, is smaller than the weapon; and the resulting cicatrix is always smaller than the wound. Hence it is difficult to judge of the size of the stabbing instrument from an exami-

nation of an old cicatrix. Cicatrices arising from a loss of substance in the cutis, or true skin, are usually indicated by a depression. In gun-shot wounds, if the projectile has been fired from a distance, the cicatrix is of smaller dimensions than the ball. It represents a disk depressed in the centre, and attached to the parts beneath, while the skin is in a state of tension from the centre to the circumference. The amount of depression is great in proportion to the quantity of loose cellular membrane beneath. If the bullet has been fired near to the body, the cicatrix is large, deep, and very irregular. In this case there may be the bluish marks of tattooing from the gunpowder carried into the skin. If the projectile has made two apertures, the aperture of exit is known by the greater size and irregularity of the cicatrix. (See 'Ed. Monthly Journal,' 1854, 10, 370.) As the age of a cicatrix increases, it becomes smaller, thicker, whiter, more shining and less sensitive. It is fibrous in structure—dense, without sebaceous follicles, adipose cells, or hairs, and it contains but few absorbents and exhalants.

There are no appearances in a cicatrix which will allow us to fix the *date* at which the wound leading to its production was inflicted, and it is often very difficult to say how or by what means it was inflicted. If the person is living, he may give a description of the injury and the date of its production, consistent or inconsistent with the appearances presented. As Casper justly remarks ('Ger. Med.' 1, 115), it requires more than two, three, or four weeks to produce the hard white shining appearance of an old cicatrix; but when it has once acquired these characters, there are no medical data for enabling us to determine whether the injury was inflicted two, three, or even ten years before. A proper attention to the number, situation, and appearances presented by cicatrices on the living or dead body, will, however, sometimes enable a medical witness to establish or disprove the identity of persons.

Cicatrices from wounds or disease. Imputed.—As there are imputed wounds, so there may be imputed cicatrices. It is rare to hear of frauds of this description: the wound must be made in anticipation at a long date in order to give the appearance of an old cicatrix—the part wounded must be selected in order to carry out the fraud, and the person producing the wound may carry the incision or puncture too deeply or too superficially, and thus lead to detection. It is more likely that an impostor may seek to gain his object by attributing the cicatrices of wounds accidentally received to other causes, or by ascribing cicatrices which have resulted from disease, to some particular cause occurring in early life. By a remarkable coincidence two persons may have cicatrices on or about the same part of the body, produced by cuts, punctures, or abscesses in early life; and serious mistakes may be made under these circumstances. A case is reported to have occurred in France in 1794, in which a man named *Lesurgues* was tried, convicted and executed for robbery and murder. There were some doubts at the time as to his identity, and strong exertions were made to save his life. Soon after his execution the real murderer was discovered, between whom and Lesurgues, who had had no hand or part in the crime, there existed a wonderful resemblance in stature, complexion, and features. But the most extraordinary part of the case was that Lesurgues, like the real criminal, had a cicatrix or scar on the forehead, and another on the hand; and there is no doubt that these points of resemblance, which upon a proper scientific examination might have been proved to be really different, became the turning-point of the case and led to the conviction of an innocent person.

On the other hand a vulgar impostor, with old scars upon his person, may make use of them as proofs of identity. Such scars may exist: they may be clearly proved to be of old date, and they may be assigned to causes which cannot be disproved except by a close medical examination. The scars or

cicatrices may have arisen from scrofulous ulcers or abscesses, in which case it would not be difficult to distinguish them from the cicatrices of wounds. In the case of *Smyth* v. *Smyth* (Gloucester Summer Assizes, 1853), the plaintiff claimed to be the rightful heir to certain estates held by the defendants. He based his claim upon certain deeds (alleged by the defendants to have been forged), in which it was stated that the lost heir to these estates would be known by certain marks on his right hand and wrist, suggested to have been received at the time of his birth, in 1797, by reason of his having been brought into the world with instruments. It was one of the curious features of this extraordinary case of imposture that no medical opinion was taken or required by the claimant on the probable nature and origin of these marks. When requested at the trial to show his hand to the jury, the mark had the appearance of a puckered cicatrix from a scrofulous ulcer near the wrist. Similar marks from scrofulous sores were seen upon his neck. His statements regarding himself, and the circumstances on which he based his claim, were so improbable and contradictory that the case speedily broke down. A question of this kind may occasionally present some difficulty, but a close examination of the cicatrix, with a consideration of the statement of the person on its mode of production, will enable a practitioner to arrive at a satisfactory conclusion respecting its origin. *Scrofulous* ulcers are generally observed to leave irregular and deeply-furrowed cicatrices, with smooth depressions, surrounded by hard and uneven margins. According to Schneider, the *scorbutic* cicatrix is dark, bluish-red in colour, soft to the touch, somewhat raised and rather painful; in the course of time it becomes flatter, of a reddish-brown colour, approaching to green (?) in the centre, is very thin and easily injured. *Syphilitic* cicatrices are characterized by great loss of substance: they approximate the margins of deep ulcers before their granulations have had time to reach the surface. *Glandular* cicatrices are irregularly tumefied, generally deep, hard, and of a reddish-brown colour. These varieties cannot easily be mistaken for the cicatrices of wounds; but it is not so easy to distinguish them from each other. M. Malle remarks that the form and shape of the cicatrix depend less on the cause producing it than on its anatomical position. The elasticity of the skin, the looseness or density of the cellular tissue beneath, the depression or convexity of the surface and the tension of the muscles, are conditions which will modify the form of the ulcer as well as the cicatrix proceeding from it ('Ann. d'Hyg.' 1840, 1, 430). An expert can seldom do more than distinguish the cicatrices of ulcers arising from morbid causes, from those which have resulted from violence. Cicatrices in the inguinal regions raise a presumption that they are of *syphilitic* origin, but it is impossible to say that they may not have been derived from simple abscesses. The old cicatrices of *scrofulous* ulcers have some resemblance to those produced by fire-arms, but it may be presumed that they are of scrofulous origin when they are situated in the region of the neck, below the jaw, or in the course of the parotid gland, especially when there is any enlargement of the neighbouring glands. A puckered and folded state of the skin around the cicatrix would confirm this opinion.

Evidence from cicatrices.—The identity of a person may depend on the presence or absence of cicatrices. In the former case a medical jurist may be required to give an opinion on the cause and date of their production, and in the latter he may be required to say whether, assuming them to have once existed, they could have disappeared, either from natural causes or from chemical or other means employed to obliterate them. In some countries it is the custom to brand convicts, and the cicatrix from the brand-mark—a letter burnt into the skin—is regarded as the strongest proof of identity. In 1828 a man, D., was convicted of forgery and condemned to the gallies for

ten years by the Criminal Court of Brabant. After a short imprisonment he was set free, on the condition that he left the country and never returned. Before his liberation he was examined by M. Vandelaer, a medical jurist, and he observed that there was upon his arm a cicatrix, or 'indelible' mark like that produced by branding. D. went to France, and in 1846 committed forgery and fled the country. The French Government, having reason to suspect that the accused had escaped, and was then living at Brussels under the name of H. B., demanded his extradition. H. B. was arrested, but he denied that he was the person sought for (D.), who had received the conditional pardon in Belgium in 1828. The question of his identity was brought before the Court of Assizes at Brabant. The accused persisted in his denial that he was the man who had been condemned by the Brabant Court for forgery eighteen years before. Several officials of the prison in which D. had been confined at that date came forward, and deposed that there was a strong resemblance in the person now charged to the former prisoner, but they declined to testify on oath that he was the same man. M. Vandelaer was then summoned, and required to state whether he could detect on the arm of the accused H. B. the mark, or scar, which he had seen on the arm of D. in 1828. He deposed that there was no mark of a brand on the accused, but at the same time he gave his opinion that the absence of such a mark was not a proof of the non-identity of the accused with D. He assigned as sufficient reasons for its disappearance the length of time which had elapsed, and the probable use of some artificial means to cause its removal! M. Vandelaer admitted that the mark which he saw on the arm in 1828 had been produced by a red-hot iron, and he thought that such a mark might be partially (?) obliterated by time. Drs. Lebeau and Limanges, who were also called as experts, denied the accuracy of this conclusion. Owing to this difference of opinion, the Court required reports from the physicians of the prisons of Vilvorde and Gand. They agreed with M. Vandelaer that a scar, or cicatrix made on the shoulder with red-hot iron might disappear after a certain lapse of time, and by the aid of certain means known to convicts! They were therefore not surprised to learn that such a mark, seen in 1828, was no longer visible in 1846! Upon this the Court decided that the identity of the prisoner was proved, and sentenced him accordingly (*Gazette Médicale*, Mars 1847).

It will be seen that the medical evidence of identity was here made to rest upon the possible disappearance of a mark from branding with a red-hot iron, after the lapse of eighteen years, without leaving the slightest trace of its existence. This is contrary to all experience, and the reasons assigned by the assessors are as unsatisfactory as the opinion which they gave. Instead of furnishing any facts to show that such cicatrices from red-hot iron had disappeared within their knowledge, they relied upon the statement of one convict that he had been branded on both shoulders, and the marks had disappeared, and upon the averment of another that he had caused the cicatrix to disappear by the application of a red-herring to the burnt part! It would have been a safer and more prudent course to state that there was a want of proof of identity from physical marks. The man, D., may have been the same as H. B., but this was certainly not proved by this negative medical evidence.

The cicatrix left by an *issue* cannot be mistaken for a cicatrix caused by a *seton*. In the first place, it is single, depressed below the level of the skin and rounded in its margin; and, as in all cases in which the cutis is destroyed, it remains indelible. It is impossible by any process to restore to the skin its uniformity of surface. A *seton* leaves two cicatrices and a hard band of lymph between the two.

The cicatrices left as a result of the application of the true *vaccine* lymph

have an irregular honeycombed appearance with white streaks, and is slightly depressed below the level of the surrounding skin. The spurious vaccine mark is of a reddish colour, not depressed, and not presenting the honeycombed appearance and white streaks of the cicatrix of the true pustule. The scars produced by *small-pox* are in the form of deep depressions, showing a complete destruction of the cutis.

The cicatrices of wounds from the performance of *surgical operations* are commonly well indicated by their regular form and their situation. They may present the characters of punctured or incised wounds, or of a division of parts for the removal of tumours. As the healing process is assisted by art, the cicatrices are commonly marked by great regularity. The identity of a living person, or of a dead body, may be proved by the existence of a cicatrix which has been the result of a surgical operation. There can be no pretence for saying that such cicatrices, when they have involved the true skin, disappear. Whether the arm is wrinkled or unusually fat, the cicatrix may be found if it has ever existed.

A trial took place at the Old Bailey in 1834, in which the late Mr. Carpue was able to rescue a man, who was wrongly charged with being a convict and with having unlawfully returned from transportation. The chief clerk of Bow Street produced a certificate, dated in 1817, of the conviction of a person, alleged to be the prisoner, under the name of *Stuart*. The governor of the gaol in which Stuart was confined believed the prisoner to be the person who was then in his custody. The guard of the hulks to which Stuart was consigned from the gaol, swore most positively that the prisoner was the man. On the cross-examination of this witness, he admitted that the prisoner Stuart, who was in his custody in 1817, had a wen on his left hand; and so well marked was this, that it formed a part of his description in the books of the convict hulk. The prisoner said his name was *Stipler*: he denied that he was the person named Stuart, but from the lapse of years he was unable to bring forward any evidence. The Recorder was proceeding to charge the jury, when the counsel for the defence requested to be permitted to put a question to an eminent surgeon, Mr. Carpue, who happened accidentally to be present in court. He deposed that it was impossible to *remove such a wen as had been described without leaving a mark or cicatrix.* Both hands of the prisoner were then examined, but no wen, nor any mark of a wen having been removed by a surgical operation, was found. Upon this the jury acquitted the prisoner. It is highly probable, however, that but for the accidental presence of Mr. Carpue, the prisoner would have been convicted and transported for life, from the unfortunate resemblance which he was supposed to bear to the real convict, Stuart.

A man may allege, in proof of his identity, that at a former period of his life he was bled in the arm, foot, or temporal artery, that he had undergone cupping, or that he had had a seton or issue in his arm. The simple questions for a medical witness will then be—Are the marks of bleeding or cupping present? Are they visible in the situations in which such operations are usually performed? and if present, Are they such cicatrices as would be likely to result from the alleged operations? If not visible at the time of examination, is it, or is it not, probable that they may have spontaneously disappeared by lapse of time? These simple questions may carry with them momentous issues, either in a civil or a criminal case. With regard to *cupping*, when the operation is properly performed, the numerous small and slightly elliptical cicatrices are well indicated by their whiteness and symmetrical position. The cicatrix left by the use of the lancet in *bleeding* from a vein in the arm or foot, is similar to that of cupping, white, linear, slightly elliptical, with its length in the direction of the vessel, and not

across it. Between forty and fifty years ago, bleeding was a frequent operation, the same person requiring to be bled at spring and fall. The cicatrix that resulted was always perceptible; in some instances, when the person had been bled in or near the same part of the vein, a hard or knotted white cicatrix was produced, raised above the level of the skin. There is no reason to believe that such a mark, involving as it does the whole cutis, ever disappears. Dr. Beck quotes the case of a child, which had been bled in the right arm when sixteen months old. When nearly four years old the child was lost, and two years subsequently, the godmother, seeing two boys pass, was struck with the voice of one of them; she called him to her, and was convinced that it was her lost godson. The identity was also considered to be proved by the discovery of a cicatrix from bleeding in the right arm, and a cicatrix from an abscess in the left knee, both of which were present in the lost child, and also in the one that was found. The latter, however, had upon his body marks of the small-pox, while no marks of this kind were on the body of the former. The child was claimed by a widow (*Labrie*), and many witnesses deposed that it was really her son. The Court decided in her favour, chiefly on the ground that the lost child was not marked with the small-pox (Med. Jour., vol. i. p. 655).

It was admitted that this child had in the arm and knee cicatrices similar to those which were known to exist in the one that was missing, and had the medical witnesses agreed about the causes of them, it is probable that the decision would have been different. The cicatrix at the knee was ascribed to the use of caustics by some of the surgeons, and to a slight tumour or abrasion by others. The widow Labrie admitted that her child had never been bled in the arm, while the missing child had certainly undergone this operation; but on so simple a question as the presence of a cicatrix from bleeding, there was a conflict of medical opinion! Three surgeons examined the cicatrix, and declared that it had been made with a sharp instrument. Others deposed that it was not a cicatrix from bleeding, but from the opening of an abscess. As the child had been missing two years, it might have had small-pox in the meantime. If a proper examination of the two cicatrices had been made by *medical assessors* appointed by the Court, this conflict of opinion would not have arisen, and the decision might have been different.

According to Casper, the cicatrix left by venesection may sometimes disappear, although he adduces no fact in proof of it (Gericht. Med., vol. 1. p. 113), while all surgical experience is, I believe, decidedly against it. Devergie correctly states that every wound which involves the thickness of the skin, leaves a cicatrix which is indelible (Médecine Légale, vol. ii. p. 217). According to him, it may become less distinct by time, but it never disappears.

In all contested cases of this kind, where there is ample room for a difference of opinion, it would be more satisfactory to take the evidence of *skilled medical assessors*, appointed by the Court, than to receive that of medical men specially selected by solicitors to uphold their different views of the case. This would be giving its true value to medical testimony, in aiding, by a proper interpretation of physical signs, to clear away the doubts which necessarily arise by trusting to a supposed resemblance of features, voice, and gesture, after the lapse of many years.

Independently of cicatrices from local injury, these cases of identity may present other physical signs, such as *moles*, *nævi materni*, and other congenital defects to which ordinary witnesses may be able to testify. There can be no fallacy of memory touching the form, size, and position of such marks, and they differ from cicatrices in this—they cannot be artificially imitated. They may, it is true, be removed, but only by actual cautery or caustic applications. If thus removed, a cicatrix is left which is indelible. A case is

reported by Dr. Beck in which a girl, *Salomé Muller*, had been sold as a slave, but her identity as the child of German parents, was proved after fifteen years, by two marks resembling moles about the size of coffee-grains, on the inside of the thighs. They were proved to have existed in the child, and they were proved to exist in the same parts of the body of the girl eighteen years afterwards. After much litigation she was, upon this evidence, pronounced to be a free woman ('Med. Jur.' vol. i., p. 662).

Coloured cicatrices. Tattoo marks.—Small punctured wounds made into the true skin with three or four sharp needles, dipped in colouring matter, leave marks which may or may not be indelible, according to the mode in which the operation is performed. The subject of tattooing has been noticed by medical jurists. It has been made use of as evidence in cases of disputed identity. See papers by Dr. Tardieu, 'Ann. d'Hyg.' 1855, 1, 171; also by Dr. Horteloup, in the same journal, 1870, vol. 2, p. 440; and Casper's 'Gerichtliche Medicin,' vol. 1, p. 115. The colours commonly employed in tattooing are indigo, charcoal (gunpowder), China-ink, and vermilion. Although China-ink and charcoal are black, the effect when introduced into a white skin is to produce with either, a blue or bluish-coloured mark. The foreign matter thus introduced mechanically into these minute punctured wounds causes inflammation, but this soon passes off, and the colouring matter then remains permanently encysted in the substance of the cutis, or below it. It has been there found after death.

From researches made by competent observers, these coloured marks are not necessarily indelible. They have, however, been observed to remain for fifty years and upwards when the colouring matter was carbonaceous, and for forty years in a case in which red cinnabar was used; but it is not so much from the lapse of time as from other accidental causes, that the marks may become faint and ultimately disappear. The depth in the cutis to which the needles have been carried, and the nature of the colouring matter employed, are the chief circumstances on which the durability of these marks will depend. The red colours are the most disposed to fade, while the black, especially that of China-ink, is among the most persistent. In one instance of a near relative I have known the marks from this colour to remain unchanged in the skin of the inside of the arm, for twenty-seven years. The thinner the skin, and the less the depth to which the needles have penetrated, the more readily do these marks fade and disappear. Something also must be set down to the skill and experience of the operator. Casper states that while he has seen the tattoo-marks remaining in some cases after forty years and upwards, in two instances they had entirely disappeared after thirty-six and thirty-eight years respectively. (Op. cit. p. 116.) It is possible to remove these marks by caustic applications, or by the actual cautery, but such an act is necessarily indicated by the production of cicatrices; for if the tattooing is complete, the removal can be effected only by the destruction of the cutis. In one instance of attempted removal, a fatal result followed. ('Ann. d'Hyg.' 1855, 1, 199.)

In the Tichborne case now pending (*Tichborne* v. *Lushington*, C.P., 1871–2, and the *Queen* v. *Castro* or *Tichborne*, Q.B., August 1873), many of the medico-legal questions in reference to cicatrices, their mode of production, date, &c., are involved. The evidence of identity derivable from tattoo-marks in the skin, and the possibility of removing such marks by the actual cautery, or by chemical substances, are also points raised in this inquiry. As this case is still *sub judice*, I refrain from making any comments on the medical evidence which has been already given for and against the claimant.

When was the wound inflicted?—In bodies long dead there may be some difficulty in distinguishing the effects of gangrene in a wound from those of putrefaction. Gangrene implies the death of a part in the living body and putrefactive

changes take place in the dead part, as in the entire dead body. If changes resembling those of gangrene are found in a wounded limb while the rest of the body is not in a putrescent state, there may be some reason for the opinion that there was gangrene during life. In this case, however, due allowance should be made for the more rapid decomposition of wounded parts. The best evidence will be that which shows the actual condition of the injured part in the living body. If putrefaction is advanced, the opinion of a person who has not seen the deceased while living can be little more than a conjecture.

The time at which a severe *contusion* has been produced may be commonly determined by noting the changes of colour which take place around it. It is rarely until after the lapse of twenty-four or thirty-six hours that these changes of colour appear. (See Ecchymosis, *ante*, p. 466.) The livid circumference passes into a green circle, which is gradually diffused into a wide straw-yellow band, bounding the ecchymosis on every side, if it be in a free or loose part of the skin. In four, five, or six days, the dark livid colour slowly disappears from the circumference to the centre, while the coloured bands spread more widely around. A central dark spot may be perceived after ten days or a fortnight, and in an extensive ecchymosis it is some weeks before all traces of colour are lost. The rapidity of these changes will be modified by circumstances elsewhere stated. Observations of this kind often lead to useful results when proper caution has been taken. The appearances presented by a contusion inflicted recently before death, and of another inflicted some days before, are of course different; and by an appreciation of this difference, a person charged with murder may or may not be connected with one or the other period of infliction, or with both.

Such is an outline of the facts which may occasionally enable us to say how long before death particular injuries have been received; or to assign a probable period for their infliction on the living. By their aid we may have it in our power to determine whether two wounds found on a dead body were or were not inflicted at or about the same time. The law in these cases seldom requires a precise medical opinion; indeed, it would be scarcely possible to give this under any circumstances. If a medical witness can only state *about* what time the injury was inflicted, circumstantial evidence will make up for the want of great medical precision or accuracy on the point.

How long did the wounded person survive?—This question, it will be perceived, is indirectly connected with the preceding, although sometimes put with an entirely different object. Supposing the wound not to have been such as to prove rapidly fatal, the length of time which a person has survived its infliction may be determined by noting whether it has undergone any changes towards healing, and in what degree. As a wound remains in the same state for about eight or ten hours after its production, it is not possible to say within this period how long the person may have survived. Then it has been supposed that a medical opinion might be formed from the nature of the injury, and the parts which it has involved. Thus, a wound may have involved large bloodvessels, or organs important to life; in this case it is pretty certain that the wounded person must have died speedily. Let us, however, bear in mind that these so-pronounced rapidly mortal wounds sometimes do not prove fatal until after the lapse of some hours or days—a fact which has been much overlooked by surgeons, although of considerable importance in relation to the medical jurisprudence of wounds.

CHAPTER 45.

ACTS INDICATIVE OF VOLITION AND LOCOMOTION—INJURIES TO THE HEAD NOT IMMEDIATELY FATAL—WOUNDS OF THE HEART NOT IMMEDIATELY FATAL—WOUNDS OF THE CAROTID ARTERIES—LOCOMOTION AFTER RUPTURES OF THE DIAPHRAGM AND BLADDER—SUMMARY.

Acts indicative of volition and locomotion.—In cases of death from wounds criminally inflicted, it is often a matter of serious inquiry, whether a person could have performed certain actions, or have moved after receiving an injury which is commonly regarded as necessarily mortal, and likely to destroy life speedily. In respect to wounds of a less grave description, if we accept those affecting the limbs directly, which will be hereafter examined, the power of willing and moving in the person who has received them cannot be disputed. The best way of treating this subject will be, perhaps, to select a few cases of severe injuries to important parts or organs, which are usually considered to destroy life rapidly. The question relative to the power of exercising volition and locomotion, has been chiefly confined to those cases in which there were injuries to the heart, wounds of the head, the large blood-vessels, the diaphragm, and bladder.

Cases have been frequently brought into Guy's Hospital, where a patient who had received a blow on the head has survived several hours or days; and after death, such injury to the cranium has been found as would, if the person had been seen only when dead, have probably given rise to a medical opinion that he must have died instantly. On the other hand, a person may fall lifeless from a blow which would produce no appreciable physical changes in the cranium or its contents; yet in this case, if the facts had been unknown, it would have been said the person might have survived some hours or days. Thus, then, we see that it is by no means easy to determine, from an examination of a wound in a dead body, how long the person actually lived after its infliction. By this remark it must not be understood that an opinion on this subject is never to be expressed from the nature and extent of an injury, but what should be impressed upon a medical jurist is, that it must not be hastily given; for a groundless suspicion of murder may be thereby excited against some innocent person. A wound may be mortal, but it by no means follows that it should have destroyed life instantaneously. As an illustration of the evil results of the practice of giving these hasty medical opinions, I may take a case which, to my knowledge, has occurred twice under almost similar circumstances. A man is found dead in his chamber with his throat cut, and the incision is proved to involve one or both carotid arteries. The medical inference is that he must have fallen dead on the spot, and that he could not have survived an instant. If this be true, the weapon ought, of course, to be found either in the hand of the deceased or close to his body; but it is lying in another room, and there are marks of blood between the two rooms. What, then, is the conclusion? Either that the medical opinion is erroneous, and the deceased could not have dropped down dead *instantly*, or that he must have been murdered! This is, of course, a serious alternative; and unless circumstances tend to expose the error of the medical statement, irreparable injury may be done to an innocent person. The medical opinion has always given way when circumstances refuting it appeared: but it is the duty of a medical jurist to profit by such errors—to apply his opinions with greater caution to similar cases, and not to wait for their refutation by incontrovertible facts.

Injuries to the head not immediately fatal.—The following case occurred a few years since in the Norfolk and Norwich Hospital:—A boy, owing to the

bursting of a gun, had the breech-pin lodged in his forehead. He got out of a cart, in which he had been brought four or five miles, and walked into the hospital without assistance. The pin was firmly impacted in the frontal bone about the situation of the longitudinal sinus. On its removal, a portion of brain came away with several pieces of bone, and the aperture in the cranium was nearly an inch in diameter. Symptoms of coma then came on, and the boy died in forty-eight hours. The brain was found to be considerably injured. ('Med. Gaz.' vol. 18, p. 458.) Mr. Watson mentions a similar case. During a quarrel between father and son, the latter threw a poker at the former with such violence that the head of the poker stuck fast in his forehead, and was with some difficulty withdrawn. The father asked those who were near him to withdraw the weapon, and he was afterwards able to walk to the infirmary. He died from inflammation of the brain. ('On Homicide,' 62.) A case occurred to Dr. Wallace, of Dublin, in which a man fell from a scaffold on the summit of his head. He was stunned by the fall, but on reaching the hospital, dismounted from the car which conveyed him, and walked upstairs with very little assistance. He died in three days, but he remained perfectly rational, and was enabled to get up and go to the water-closet the day before his death. On inspection, there was only a slight abrasion on the summit of the head, but the skull was found split into two nearly equal halves from the frontal bone backwards, and the longitudinal sinus was laid open throughout. In the hemispheres of the brain there was a large quantity of effused blood in a semi-coagulated state, and more than two ounces were found at the base of the skull. ('Lancet,' April 1836.) Supposing this person to have been found dead with such extensive injuries, the medical opinion would probably have been that he was not likely to have lived or moved afterwards; and yet the power of volition and locomotion remained with him for two entire days! (See also a case by Mr. Codd, p. 480.)

Dr. Cunningham, of Hailsham, mentions the case of a boy who met with an accident while firing a pistol. The pistol burst, and there was no doubt that the breech had entered the brain, although it could be nowhere perceived. The boy remained sensible for two days; and although some amendment took place, he died twenty-four days after the accident. The breech of the pistol, weighing nine drachms. was found lying on the tentorium, and the brain was much disorganized. ('Lancet,' July 1838.) In this case the boy was shot completely through the brain, a heavy mass of iron having traversed that organ, but he was not even rendered insensible by so serious a wound. (See also 'Med. Gaz.' vol. 36, p. 38.) The medical opinion, in an abstract question of this kind, is commonly based on individual experience; but the real question is, not whether the witness himself has seen such a case, but whether such a condition of things is medically possible. If all opinions in a Court of Law were to be founded on personal experience only, many medical facts, important either to the prosecution or defence, would be lost, because the witness by mere accident might never have met with such exceptional cases. On these occasions a witness is allowed to express an opinion from general professional knowledge and experience.

The importance of these observations will be further seen by the following medico-legal case, reported by Dr. Wallace. A man was found dead in a stable with a severe fracture of the temporal bone, which had caused a rupture of the middle artery of the brain. A companion was accused of having murdered him, but he alleged that the deceased had fallen from his horse the day before, and had thus met with the accident. It appeared, however, that after the fall, the deceased had gone into a public-house before he returned to the stables, and had remained there some time drinking. The question respecting the guilt of the accused party rested upon the fact whether, after such an

extensive fracture of the skull with extravasation of blood, it was possible for a man to do what the prisoner had represented the deceased to have done. Dr. Wallace gave, very properly, a qualified opinion; he said it was improbable, but not impossible, that the deceased could, after receiving such an injury, have walked into and drunk at a public-house. The extravasation was here the immediate cause of death, and probably this did not take place to the full extent, except as a consequence of the excitement from drink.

It is easy to suggest many cases in which a question of this kind will be of material importance. For instance, a man may fall from a height, and produce a severe compound fracture of the skull. He may, nevertheless, be able to rise and walk some distance before he falls dead. (See case, *ante*, p. 480.) Under these circumstances there might be a strong disposition to assert that the deceased must have been murdered—the injuries being such that they could not have been produced by himself, there being at the same time no weapon near, and no elevated spot from which he could have fallen. The discovery, after death, of severe injury to the head, with great effusion of blood on the brain, must not lead a surgeon to suppose that the person who sustained the violence had been immediately incapacitated. In *Reg.* v. *Milner and others* (Derby Summer Assizes, 1854), in which a Mr. Bagshawe had been assaulted by the prisoners and had died from the injuries sustained, it was proved that the temporal bone was beaten in, the base of the skull fractured, and there was a large coagulum of blood effused on the left side of the brain, which by its pressure had flattened this organ. Notwithstanding these injuries, deceased walked a considerable distance, and he survived about twelve hours. There is reason to believe that in this and other cases of a similar fatal kind, the effusion of blood was an after-result.

Wounds of the heart not immediately fatal.—Every penetrating wound of the heart was formerly considered to be instantaneously mortal, and the usual medical opinion at coroners' inquests was that a person so wounded must have dropped down dead on the spot. More accurate observations have, however, shown that this is an erroneous, and, in medico-legal practice, a highly dangerous doctrine. The *Duc de Berri*, who was murdered in Paris in 1820, survived eight hours after having received a wound in the left ventricle of the heart. Other and more remarkable instances of survivorship will be adduced hereafter; in the meantime it may be stated, that, although in a surgical view, a question of this kind is of little importance, the case is very different in legal medicine. Upon it may depend the decision of questions relative to suicide, murder, or justifiable homicide. When the cavities of the heart are extensively laid open, death is likely to be an immediate result; but persons who have sustained wounds of this organ have frequently lived sufficiently long to exercise the power of volition and locomotion. Mr. Watson met with a case in which a man who had been stabbed in the right ventricle ran *eighteen yards* after having received the wound. He then fell, but was not again able to rise; he died in six hours. On dissection, it was found that a punctured wound had extended into the right ventricle in an obliquely transverse direction, dividing in its course the coronary artery. The pericardium was nearly filled with blood, and about four pounds were effused on the left side of the chest. ('On Homicide,' p. 98.) One of the most remarkable cases of the preservation of volition and locomotion after a severe wound of the heart will be found reported in the 'Medical Gazette' (vol. 14, p. 334). In this case the patient, a boy, survived five weeks, and employed himself during that period in various occupations. After death a mass of wood was found lodged in the substance of the heart. Had this boy been found dead with such an injury, it is most probable the opinion would have been that his death was instantaneous. Dr. Darling, of New York, has communicated to me the particulars of a case which occurred

in February 1855, in which a man survived for a period of *eleven days* a bullet-wound of the heart. Soon after receiving the wound he became senseless, cold, and pulseless, and remained in this collapsed state for four hours. He then rallied, but died on the eleventh day. On inspection, there was no effusion of blood: the pericardium was much distended with serum, the result of inflammation. A bullet, one-third of an inch in diameter, was found lodged in the septum or fleshy partition between the right and left ventricles, about midway between the apex of the heart and base of the ventricles. There was no communication with the cavities—the wound had entirely cicatrized; and inflammation of the pericardium was obviously the cause of death.

The following case, reported by one of the editors of Beck's 'Medical Jurisprudence,' will show the bearing of the medico-legal question. It was here material to the defence of the prisoner. The keeper of a brothel was tried in Glasgow, in the year 1819, for the murder of a sailor, by shooting him through the chest. It appeared from the evidence of the medical witnesses, that the auricles and part of the aorta next to the heart were 'shattered to atoms,' by the slugs and brass nails with which the piece was charged; and in their opinion, the deceased must have dropped down dead on the moment that he received the shot. The body was found in the street, and the door of the prisoner's house was *eighteen feet* up an entry; so that it followed, if the medical opinion was correct, that the prisoner must have run after the deceased, and shot him in the street. For the prisoner it was urged and proved, that he had shot the deceased through the door of his own house, which the latter was attempting to enter by force. Besides direct testimony to this effect from those within the house, and from a lad who was with the deceased at the time, it was proved that there was a stream of blood from the door of the house to the spot where the body lay, which could not have flowed from the body towards the house, as the threshold of the door was on a higher level than the pavement of the street. On this evidence, the prisoner was acquitted. If, by the heart 'being shattered to atoms,' we are to understand that its cavities were entirely laid open, and its substance destroyed, we have a description of wound which most professional men would not hesitate to pronounce instantaneously mortal. Although nothing is stated on the point, yet we must suppose it was proved before the question of survivorship was raised, that the body of the deceased could not have been dragged after death from the door of the prisoner's house to the spot where it was found; a circumstance which would have sufficed to account for the presence of a stream of blood, notwithstanding the difference of level between the street and the door of the house. The question was of importance to the prisoner, inasmuch as if he had shot the deceased while the latter was endeavouring to break into his house, the homicide might have been regarded as excusable; but if, after the deceased had left the house, he had run into the street and shot him, then probably this would have been considered sufficient evidence of malice to have justified a verdict of wilful murder. The jury adopted the first view of the case; and found that, in spite of the severe wound, the deceased had had the power to run into the street, after having been shot through the door of the prisoner's house.

A case of some interest in reference to the power of surviving a severe wound of the cavities of the heart, occurred at Guy's Hospital, in February 1854, for the particulars of which I am indebted to the late Mr. Callaway. An Italian, æt. 38, discharged a brace of pistols into his chest on the left side. The man was brought to the hospital, was able to converse on his condition, and lived one hour and fifteen minutes after the infliction of the wound. After death it was found that one bullet had perforated the pericardium, entered the right ventricle, and, after traversing the septum of the ventricles, made its exit from the heart at the junction of the left auricle with the ventricle. It traversed

the upper lobe of the left lung, and was found fixed in one of the vertebræ of the back. The second bullet perforated the left ventricle, and then traversed the left lung. This wound was of such a nature that, at every contraction of the ventricle, the opening must have been closed so as to arrest the flow of blood. This man, owing to severe suffering, rolled about the floor, and was with difficulty kept quiet. It will be seen that in this case there were bullet-wounds traversing completely the cavities of the heart; yet the man could talk and exert himself, and he actually survived their infliction *one hour and a quarter.* Had the body been found dead in a suspicious locality, the discovery of such wounds in the ventricles of the heart might probably have led to a hasty medical opinion that the death of the man must have been instantaneous. In these cases, little or no blood probably escapes from the heart in the first instance, but it may afterwards continue to ooze gently, or suddenly burst out in fatal quantity. It must not, therefore, be supposed, when a person is found dead with a wound of the heart, attended with abundant hæmorrhage, either that the flow of blood took place in an instant, or that the person died immediately and was utterly incapable of exercising any voluntary power. Only one condition will justify a supposition of this kind; namely, when the cavities of the organ are largely laid open. This remark applies especially to wounds of the auricles, which have but little contractile power.

Wounds of the carotid arteries not immediately fatal.—Questions relative to the power of locomotion perhaps more frequently occur with respect to wounds of the great blood-vessels of the neck than of the heart—suicide and murder being more commonly perpetrated by the infliction of such wounds. Wounds of the carotid arteries are often pronounced *instantaneously* mortal. A witness may deliberately state that the person could not possibly have survived an instant. This is a very hazardous opinion, for it occasionally comes out on inquiry that, if such a wound had been instantaneously mortal, then, in defiance of rational probability, or of the strongest presumptive evidence to the contrary, the deceased must have been murdered! A medical opinion of this kind has not only been refuted by circumstances, but by the evidence of eye-witnesses. A medical witness is then compelled to admit that his rules for judging of the mortality of wounds are wrong, and that the person may have survived for a longer or shorter period. There are several cases on record which show that wounds involving the common carotid artery and its branches, as well as the internal jugular vein, do not prevent a person from exercising voluntary power, and even running a certain distance. Mr. Clegg, coroner for Boston, informed me that, in 1863, he held an inquest on the body of a man who committed suicide by cutting his throat. The external carotid artery and the jugular vein on the right side were cut through, and a large quantity of blood was lost. The wound extended from the front of the angle of the right jaw to near the windpipe, which was not wounded. The man survived half an hour, but he was speechless and insensible. The bleeding had been partly stopped by a cloth thrust into the wound. It was left doubtful by the evidence whether this wound was inflicted by himself or by another. In a case of murder, perpetrated at Kingston in March 1831, it was proved by medical evidence that the deceased had died from a wound in the throat, involving the right carotid artery, jugular vein, and windpipe. The wound had been inflicted while deceased was lying in bed. Her body was found in an adjoining room, and the circumstances showed that, after receiving the wound, she had been able to rise from her bed, and to stagger or run to the distance of about six feet. In the case of *Rex* v. *Danks*, Warwick Lent Assizes, 1832, it was proved that the deceased had died from a wound in the throat inflicted by the prisoner, which divided the trunk of the carotid artery, the principal branches of the external carotid, and the jugular veins. The evidence rendered it probable, if not certain, that, after the infliction of this wound, the deceased

had been able to run twenty-three yards and to climb over a gate—the time required for the performance of such acts being at least from fifteen to twenty seconds. Most medical witnesses would have probably given an opinion that the deceased could not have moved from the spot where such a wound had been inflicted; but it was clear that she had gone this distance—there was no dragging of the body, and no motive for its being dragged by the prisoner, and exposed in an open road, where it was found. ('Medical Gazette,' vol. 10, p. 183.) Such cases as these show the necessity of caution in giving an opinion respecting immediate death from wounds. When the internal jugular vein has been the principal vessel involved in a wound, a similar question has presented itself. The power of moving has been exerted to a considerable extent. (See the case of *Reg.* v. *Dalmas*, p. 442; also 'Ann. d'Hyg.' 1830, p. 417.)

There is one circumstance which requires notice in relation to severe wounds in the *throat*—namely, that although a person may have the power of locomotion, he may not be able to use his voice so as to call for assistance. It sometimes excites surprise at an inquest, how a murder may, in this way, be quietly committed without persons in an adjoining room hearing any noise; but the fact is well known medically, that when the windpipe is divided, as it generally is on these occasions, the voice is lost. Wounds involving the trachea and œsophagus are not necessarily fatal if the large blood-vessels escape injury. A case of recovery from a serious wound of this kind is reported by Dr. Van Hook. The larynx was divided between the thyroid and cricoid cartilages and the œsophagus laid open. The man recovered. ('Amer. Jour. Med. Sci.' Oct. 1870, p. 576.)

Ruptures of the diaphragm.—A rupture of the *diaphragm* has been considered sufficient to deprive a person of the power of locomotion; but there appears to be no good ground for this opinion. The general effect of such an injury is to incapacitate a person; but still in some cases a power of moving and walking may be retained after a rupture of this muscle. In the following instance, reported by Devergie, the proof of locomotion was material:—An intoxicated man, after having been maltreated by another, returned home, walking for at least two hours with two companions. The man died in fifteen hours; and, on inspection, among other severe injuries, there was found a recent longitudinal rupture of the diaphragm about two inches and a half in extent, and the stomach protruded through the aperture. The question was, When could this rupture have taken place? for it was undoubtedly the cause of death. Was it possible for a person, with a recent rupture of the diaphragm, to walk for two hours? If this power of locomotion were admitted, then it followed that it might have been caused by the man who first ill-treated the deceased; if not, then that the injury had been probably caused by the deceased's two companions, for it did not appear that he had been in company with any other person. The medical witness admitted the possibility of the deceased being able to walk under the circumstances, but he thought it very improbable. There was not the smallest evidence to show that the deceased had been attacked or beaten by his two companions in journeying homewards; and, therefore, there could be no just reason for inferring their guilt simply because locomotion after such an injury was something unusual as a matter of medical experience. This injury is far from being immediately or even speedily fatal, as was formerly supposed. In January 1847, a case was communicated to the Pathological Society of London, concerning which the following particulars were ascertained. A man fell from a height of twenty feet. He had fractured both arms, and had sustained other severe injuries; on the day after admission into the hospital, he complained of a fixed defined pain on the left side. He survived about thirteen weeks. On inspection, the diaphragm was found lacerated in two places; in one to the extent of an inch, and in the other to

the extent of six inches. ('Med. Gaz.' vol. 39, p. 205.) In a case admitted into Guy's Hospital, some years since, the patient survived the only accident which could have produced the rupture for at least *nine months*. The man had fallen on the deck of a vessel, from a great height, six months prior to his admission. His ribs were fractured, and one ankle was so injured as ultimately to render amputation necessary. The man sank under the operation three months after admission; and on inspection it was found that the stomach and the colon occupied the left side of the chest, having protruded through an aperture in the muscular part of the diaphragm, two and a half inches in extent. It was evidently of old standing, as the aperture was cicatrized and the omentum adhered to it. The existence of this injury was quite unexpected, and, at the time of admission, there was nothing to interfere with locomotion and exertion except the injury to the ankle. ('Guy's Hospital Reports,' 1838, p. 368.)

Ruptures of the liver, spleen, or kidneys, unless attended at once with great loss of blood, do not prevent a person from exercising muscular power. In the case of *Gordon* (Glasgow Spring Circuit, 1856), it was proved that the deceased had died from ruptured liver; but, after sustaining the violence, he had been able to reach home on foot, although with some difficulty. This question of survivorship in reference to ruptured liver, and the time required for fatal effusion of blood to take place, may often have an important bearing in a charge of murder. (See post, *Reg.* v. *Phillips*, Liverpool Winter Assizes, 1863.)

Ruptures of the bladder.—In ruptures of the *bladder*, attended with extravasation of urine, a question may arise respecting the retention of the power of locomotion. The following cases will show that this power does sometimes exist, although the general result is, perhaps, to incapacitate the person from moving. A man, æt. 31, while intoxicated, received a blow on the lower part of his abdomen. He was sobered by the accident, and walked home, a distance of a quarter of a mile, although suffering severe pain. When seen in the evening, twelve ounces of bloody urine were drawn off by a catheter, and he complained of having felt cold immediately after he had received the blow. He died four days after the accident. On inspection there was no mark of bruise or ecchymosis on any part of the abdomen. The bladder was ruptured in its upper and back portions for about an inch. ('Lancet,' May 14, 1842.) Another case was related to me by a pupil. A gentleman who had been compelled to retain his urine, fell accidentally, in descending a staircase, with the lower part of his abdomen against the edge of one of the steps. The sense of fulness in his bladder immediately ceased, and he walked to a friend's house to dinner. The nature of the accident was mentioned to a surgeon there present, who immediately suspected that the bladder must have been ruptured. The case terminated fatally in twenty-four hours. A case is reported by Mr. Hird, in which a man walked a distance of two miles after having sustained a rupture of the bladder; and in another, which occurred in January 1852, communicated to me by Mr. Rake, the man, who sustained the injury in a scuffle, was able to walk a mile between two and three hours after the occurrence. (See also 'Lancet,' Oct. 31, 1846, p. 480.) Thus, then, from these various instances, it is evident that locomotion and muscular exertion may take place after an accident of this description. The medico-legal relations of this subject will be apparent from the following case, reported by the late Mr. Syme. A man passed some hours convivially with a few friends, after which a quarrel ensued, blows were exchanged, and the parties wrestled with each other. The deceased then walked home, a distance of more than a mile; and in crossing the threshold of his own door he fell forwards on his abdomen. When lifted up he complained of great pain, and was put to bed, being quite unable to exert himself. He died in two days, and upon dissection the bladder was found ruptured at its upper part (fundus) to the extent of between two

and three inches. Under these circumstances, it became a question whether the rupture was caused by the violence of his companions, or by the accidental fall at the door of his own house. If by his companions, he must have walked more than a mile with his bladder ruptured; but two medical witnesses declared that he could not have walked this distance after the rupture, and consequently that it must have been occasioned by the subsequent fall. The symptoms of rupture and extravasation of urine occurring immediately after the fall rendered it highly probable that this accident was really the cause. At the same time it is obvious that the power of locomotion may be exerted under such circumstances to a much greater extent than is commonly supposed.

The question is sometimes restricted to the mere possibility of *survivorship for a given period* without active exertion. If the power of locomotion is retained under severe injuries to important organs, there can be no difficulty in supposing that life may continue for a longer or shorter time when the person remains in a quiescent state. Dr. Tardieu has reported a case in which, under attempted abortion, the uterus was excessively lacerated, and the greater part of the small intestines had been torn away. These injuries had caused a great loss of blood, but the woman is stated to have lived three-quarters of an hour, and to have cried out during that time. Some medical witnesses thought that such violence could not have been sustained without leading to immediate death. A review of the facts, however, and an examination of parallel cases, satisfied Dr. Tardieu that the deceased might have survived and cried out in the manner deposed to by the witnesses. ('Ann. d'Hyg.' 1848, 1. 157.) The cases contained in this chapter fully corroborate the opinion formed by M. Tardieu. A witness must always be prepared to make full allowance for acts indicative of life in persons severely wounded.

Under survivorship from severe accidents or personal injuries, this power of moving, if not exerted to a large extent, may take place in a small degree; and this may become occasionally a material question in legal medicine. Thus it must not be lost sight of when we are drawing inferences as to the relative position of an assailant and a murdered person from the situation in which a body is found. A dead man, with a mortal injury to the head or heart, may be found lying on his face, when he actually fell upon his back, but still he might have retained sufficient power to turn over before death; or he may have fallen on his face, and have afterwards moved, so that his body may be found lying on the back. A slight motion of this kind is very easily executed; it does not always depend on volition. Individuals suffering from severe concussion have been frequently known to perform acts unconsciously and automatically. The cases above related may perhaps be considered rare, and as exceptions to the general rule. The medical jurist must bear in mind, however, that he is not required to state in how many, out of a given number of persons similarly wounded, this power of performing acts indicative of volition and locomotion may remain, but simply whether the performance of these acts is or is not *possible.* It is on this point only that the law requires information. The hypothesis of guilt, when we are compelled to judge from circumstances in an unknown case, can only be received on the exclusion of every other reasonable explanation of the facts. On surgical opinions or treatment, such cases, from their rare occurrence, may have little influence; but in legal medicine the question is widely different. Medical facts, however rare, here admit of a very important and unexpected application.

Struggling after severe wounds.—Although, in cases of severe wounds, we may allow that persons may survive for a sufficiently long period to perform various acts of volition and locomotion, yet the presence of a mortal wound, especially when of a nature to be accompanied by a great loss of blood, must prevent all *struggling* or violent exertion on the part of the wounded person;

such exertion we must consider to be quite incompatible with his condition. A medical jurist may thus have it in his power to determine whether a mortal wound found on the deceased has been inflicted for the purpose of murder, or in self-defence, as the following case, reported by Mr. Watson, will show. A man was tried at the Lancaster Assizes in 1834, for the murder of a woman at Liverpool, by stabbing her in the chest. Prisoner and the deceased, with two other women, were quarrelling in the passage of a house. A struggle ensued between the prisoner and deceased, which one of the witnesses said lasted for *ten minutes*. When the prisoner had reached the door, he pulled out a knife and stabbed the deceased in the chest. She fell, and died almost immediately. The prisoner alleged that he was attacked by several persons, and that he stabbed the woman in self-defence. The judge said, if the blow had been struck with premeditation before the struggle, the crime would be murder —if during the struggle, it would be manslaughter. The medical evidence showed that the blow could not have been struck before the struggle, because it was of a speedily mortal nature; and the deceased would not then have been able, as it was deposed to by the witnesses, to struggle and exert her strength with the prisoner for *ten minutes* afterwards. This being the case, it followed that, in all medical probability, the deceased had received the wound towards the conclusion of the quarrel; and therefore it might have been inflicted while the prisoner was attempting to defend himself. The jury returned a verdict of manslaughter.

A case involving this medico-legal question was tried at the Gloucester Lent Assizes, 1843 (*Reg.* v. *Hobbs*). The prisoner was indicted for the wilful murder of a man with whom he had been drinking and quarrelling. It appears that in the early part of the quarrel the deceased threw the prisoner down and struck him unfairly. The deceased was told by the landlord of the inn to go home. He replied 'Very well,' and then, leaving the prisoner, went through the entrance-arch of the inn up the yard, which was his usual way of going home. In about *seven minutes* the deceased, who had complained to the landlord of the maltreatment which he had undergone, returned into the inn-yard, and was seen, on entering it, to pull down his waistcoat and button his coat. A witness advised him to go home, and he left the spot. A short time afterwards he was found at the back of the yard, lying on his face and quite dead. On examining the body it was ascertained that the deceased had been stabbed in two places, one of the stabs having penetrated a ventricle of the heart. On apprehending the prisoner, a large clasp-knife was found in his pocket stained with blood. The prisoner admitted that he had stabbed the deceased, but said it was *during the quarrel*, and that he had used the knife in self-defence while they were on the ground. This was the defence. For the prosecution it was contended that the deceased had been stabbed by the prisoner subsequently to the quarrel—that he had gone through the gate into the yard to meet the deceased, had there stabbed him, and had caused his instant death. A medical witness who was called, stated at first that from such a wound death must have been *instantaneous*. In cross-examination, however, he admitted that the deceased might have lived some time after he had been stabbed; and on this evidence the prisoner was convicted of manslaughter, and sentenced to six months' imprisonment. The medical facts of this case are rather imperfectly reported: hence it is difficult to give a decided opinion respecting the time at which the deceased was stabbed in the heart. This, like every other case, must be judged by the special circumstances accompanying it. The size of the stab in the ventricle is not stated; nor is it in evidence whether any blood was found on the spot where the deceased was struggling with the prisoner. That the deceased should have struggled with the prisoner for one minute after he had been stabbed in a ventricle of the heart, is contrary to all medical experience and probability. It is also irreconcilable with the existence of such a wound, that

the deceased should have spoken to the landlord—that he should not have called the attention of the latter to the fact of his having been stabbed by the prisoner while struggling with him—that he should have been stabbed in the heart without knowing it, or without being aware of his condition—that he should have been able thereafter to walk away through the inn-yard to the house, and survive seven minutes while thus walking; and yet all these circumstances must have happened, in order that the defence, and the verdict based upon it, should be true. Taking the facts as reported, it appears to me that it is impossible to arrive at any other conclusion than that the deceased was stabbed by the prisoner subsequently to the quarrel, while he was walking in the inn-yard. The only circumstances in favour of the defence were the prisoner's statement, and that, in some rare cases, certain wounds of the heart do not prove immediately fatal.

The case of *Reg.* v. *E. M. Brown* (Dorchester Summer Assizes, 1856), presents some points of interest in reference to the question under consideration. The prisoner was charged with the murder of her husband by blows on the head while in her room. Her statement was that the violence on the head was produced by the kick of a horse. The medical evidence showed that the bones of the nose were broken: there was a triangular wound exposing the bone above the left eyebrow, another triangular wound exposing the bone at the top of the head, and a third wound at the back of the head. The left ear was perforated; and behind it was a long wound divided into two. The frontal bone was fractured from the orbit through the parietal into the occipital bone. Seven pieces of bone, varying in size from half an inch to three inches, had been driven into the brain, and a large quantity of blood was effused. The prisoner's account was that she found her husband thus wounded and bleeding outside the house, that she dragged his body into an inner room, and, further, that, though thus wounded, he held her tightly by the clothes for two hours afterward. It was proved that there was no blood over the front of the person or dress of the deceased, and that there was no blood in the passage or in any part of the house, except in the room where the body was found lying. Further, the injuries were not such as a kick from a horse would explain; and the medical witness properly stated that a man thus injured could not have held the prisoner by the clothes for two hours, so as to prevent her from seeking earlier for assistance. The medical facts showed that the deceased had been killed by blows where the body was actually found. The prisoner was convicted.

CHAPTER 46.

WOUNDS AS THEY AFFECT DIFFERENT PARTS OF THE BODY—WOUNDS OF THE HEAD—OF THE SCALP—CONCUSSION—HOW DISTINGUISHED FROM INTOXICATION—EXTRAVASATION OF BLOOD—SEAT OF—AS A RESULT OF VIOLENCE DISEASE OR MENTAL EXCITEMENT—WOUNDS OF THE FACE—OF THE ORBIT—OF THE NOSE—DEFORMITY AS A CONSEQUENCE OF WOUNDS OF THE FACE—INJURIES TO THE SPINE—FRACTURES OF THE VERTEBRÆ—DEATH FROM INJURIES TO THE SPINAL MARROW.

THE *danger* of wounds, and their *influence in causing death*, are the two principal points to which the attention of a medical jurist must be directed.

WOUNDS OF THE HEAD.

Incised wounds, affecting the scalp, unless of great extent, rarely produce any serious effects. When the wound is contused, or accompanied by much

laceration of the skin, it is highly dangerous in consequence of the tendency which the inflammatory process has to assume an erysipelatous character. The results of these wounds are, however, such as to set all general rules of prognosis at defiance. Slight punctured wounds will sometimes terminate fatally in consequence of inflammation, followed by extensive suppuration; while, on the other hand, a man may recover from a lacerated wound by which the greater part of the skin may have been stripped from the bone. There are two sources of danger in *wounds of the scalp*:—1. The access of erysipelatous inflammation. 2. Inflammation of the tendinous structures, followed or not by a process of suppuration. Either of these secondary effects may be a consequence of slight or severe wounds, and prove fatal. Neither can be regarded as an unusual result of a severe wound of the scalp; but when one or other follows a slight injury, there is reason to suspect that the patient may have been constitutionally predisposed to the attack. Bad treatment may likewise lead to a fatal result from a wound not serious in the first instance, but the question how far the responsibility of an aggressor would be affected by a circumstance of this nature has been considered in another place (*ante*, p. 589). Wounds of the head are dangerous in proportion as they affect the brain; and it is rare that a severe contused wound is unaccompanied by some injury to this organ. There is, however, a difficulty which a practitioner has here to contend with—namely, that it is scarcely possible to predict, from *external* appearances, the degree of mischief which has been produced within. These injuries, as it is well known, are capricious in their after-effects—the slightest contusions may be attended with fatal consequences, while fractures, accompanied by great depression of bone, and an absolute loss of substance of the brain, are sometimes followed by perfect recovery. ('Cormack's Jour.,' Sept. 1845, p. 653; 'Med. Gaz.,' vol. 39, p. 40; and 'Phil. Med. Exam.,' Nov. 1845, p. 696.) Another difficulty in the way of forming a correct opinion consists in the fact, that a person may recover from the first effects of an injury, but after some days or weeks he will suddenly die; and on examination of the body, the greater part of the brain will be found destroyed by suppuration, although no symptoms of mischief may have manifested themselves until within a few hours of death. The abscess in the brain must be directly traceable to the violence inflicted. In some cases it may be formed independently of such violence. See case by Dr. Deutschbein, 'Vierteljahrsschrift,' 1870, 2, 237. (For a medico-legal account of injuries to the head, see papers by M. Toulmouche, 'Ann. d'Hyg.,' 1859, 2, 395; 1860, 1, 143; and 1867, 1, 121.)

Concussion.—The common effect of a violent blow on the head is to produce concussion or effusion of blood, or both. Concussion is usually indicated by fainting, insensibility, or sudden death occurring immediately after the application of external violence. In concussion the symptoms come on *at once*, and the patient sometimes dies without any tendency to reaction manifesting itself. In the most severe form, the person drops at the very moment when struck, and dies on the spot. (Chelius's 'Surgery,' vol. 1. p. 408.) In other cases, he may linger in a state of insensibility for several days or weeks, and then die. In concussion there is generally more or less vomiting. It is important to remember, that neither compression nor physical injury to the brain is necessary to render concussion fatal. (See p. 470; also Travers's 'Constitutional Irritation,' p. 438; Chelius's 'Surgery,' vol. 1, p. 410.) This may be entirely dependent on shock to the nervous system. After death, no particular morbid change may be discovered in the body, or there may be merely the mark of a slight bruise on the head. In *Reg.* v. *Burgess* (Liverpool Lent Assizes, 1845), the deceased, who was the subject of violence, fell and died on the spot, and there was no appearance of injury externally or internally. The state of insensibility observed in concussion may be only apparent. Some consciousness may be retained.

Inflammation may follow the primary shock from concussion—suppuration may take place, and the patient die after the lapse of several weeks, or even months. (See case 'Med. Times and Gaz.,' June 30, 1860, p. 645.) It is important in a medico-legal point of view to notice that a person may move about and occupy himself, while apparently convalescent, for a week or ten days after recovery from the first shock, and then suddenly be seized with fatal symptoms, and die. This apparent recovery leads to the common supposition that death must have been produced by some intervening cause, and not by the original violence to the head—a point generally urged in the defence of such cases. (See *Reg.* v. *Kelpen*, Lewes Summer Assizes, 1871.) When the inflammation that follows concussion is of a chronic character, the person may suffer from pain in the head and vomiting, and die after the lapse of weeks, months, or even years. (See p. 560; Travers op. cit. p. 445; also Hoffbauer, 'Ueber die Kopfverletzungen,' 1842, p. 57.) Concussion may sometimes take place as a consequence of a violent fall on the feet, in which case the head receives a shock through the medium of the spinal column. The skull may be thereby extensively fractured at the base, and the brain may be even shattered by such a fall. This was the cause of death in the case of the *Duke of Orleans*. ('Med. Gaz.,' vol. 36, p. 368.)

In *Allen* v. *the Chester Railway Company* (Court of Common Pleas, Feb. 1857), the plaintiff claimed damages for an injury caused by a railway collision. The evidence showed that the plaintiff received a blow on the head. There were no immediate effects; but in two days he suffered from lightness of the head and other symptoms, attributed by his medical attendant to *concussion* of the brain, as a result of the accident. Subsequently there were symptoms of injury to the spine. There was pain in the course of the spine, partial paralysis of the bladder, rectum, and lower extremities, with loss of memory. The medical witnesses for the plaintiff attributed these symptoms to a blow received by him at the base of the skull. The defendants contended that if these were the results of concussion of the brain, they ought to have manifested themselves immediately on the occurrence of the accident; and this view was to some extent supported by the evidence of experienced surgeons. In substance, however, the medical evidence on the two sides was not conflicting. Concussion of the brain, as it is ordinarily known to surgeons, is generally attended with some *immediate* symptoms; but the witnesses for the defence properly admitted that 'a concussion of the brain (and spine?), attended with apparently slight symptoms at first, might, under peculiar circumstances, be followed by serious symptoms.' As no other cause could be assigned for the symptoms, this was practically admitting that the plaintiff had suffered from the injury, the degree being simply a question for the jury. They returned a verdict for the plaintiff.

Concussion distinguished from Intoxication.—The symptoms under which a wounded person is labouring may be sometimes attributed to *intoxication*, and a medical witness may be asked what difference exists between this state and that of concussion. The history of the case will, in general, suffice to establish a distinction, but this cannot always be obtained. It is commonly said that the odour of the breath will enable a surgeon to detect intoxication; but it is obvious that a man may meet with concussion after having drunk liquor insufficient to cause intoxication, or concussion may take place while he is intoxicated—a combination which frequently occurs. Under such circumstances we must wait for time to develop the real nature of the case. Concussion may be so slight as sometimes closely to resemble intoxication, and from the absence of all marks of violence to the head and the existence of a spirituous odour in the breath, the medical examiner might be easily deceived. If there be no perceptible odour in the breath, the presumption is that the symptoms are *not* due to intoxication. On the other hand, intoxication may be so great as to give

ances, was asked whether, in his opinion, death was occasioned by the injury proved in evidence. He said death might or might not have been occasioned by it. Death might have arisen from other causes—an apoplectic fit might have caused it. The effusion of blood was the immediate cause of death, and he had seen blood in the heads of many persons dying from apoplexy. He was not able to speak to the cause of the rupture of the vessels. He thought it highly probable that the injury received was the cause of death—it was certainly sufficient to account for it! It is not mentioned whether the man was found guilty upon this loose evidence, or whether the jury acquitted him. ('Med. Gaz.' vol. 7, p. 382.)

A case was tried at the Gloucester Summer Assizes, 1845 (*Reg.* v. *Phipps*), in which a strong opinion was expressed by Mr. Justice Patteson, in relation to the defence frequently adopted on these occasions. During a fight, the prisoner struck the deceased a severe blow under the left ear. He fell and died in a few minutes. After death, blood was found extravasated on the part corresponding to the seat of violence, and this, in the opinion of the medical witness, satisfactorily accounted for death. The defence was, that the effusion might have proceeded from over-excitement; but the judge is reported to have said that if it were proved two people were fighting together—blows were struck —one fell to the ground and died, and afterwards internal injuries were found corresponding with the external marks of violence, no power on earth could persuade him that such blows were not the cause of death! The prisoner was found guilty.

Effusion of blood causing death after a long period of time.—Admitting that blood has been effused on the brain as a result of violence, the person injured may survive the effects for so long a period as to create a legal doubt whether death can be strictly assigned to the violence. In this respect the case of *Reg.* v. *Sullivan* (C. C. C. Sept. 1853) is of some interest. The late Dr. M'William, who gave evidence at the trial, gave me the particulars of this case. Deceased, a healthy man, was knocked down by the prisoner, and fell with his head upon the ground. He appeared as if he was stunned, and staggered in attempting to walk: he complained of pain in the head and general weakness. This was on the 11th of April 1853. Although he suffered from pain in the head, he had no medical advice until the 12th of May, and had in the meantime performed his duties as an officer of the Customs. After this he suffered from dimness of sight, and became delirious. On the 29th he came under the care of Dr. M'William. There were marks of bruises on the head, there was impairment of vision, a faltering gait, and other symptoms indicative of pressure on the brain. He improved under treatment, but the symptoms returned in an aggravated form about the 12th of June; he became insane, and was transferred to St. Luke's Hospital. Dr. Stevens, under whose care he was then placed, stated that he had delusions, and was evidently suffering from pressure on the brain. He recovered so far that he was about to be discharged, when the symptoms of pressure became aggravated, and death took place on the 17th of August, *i.e. four months* after the infliction of the violence. On inspection a shot was found imbedded in the frontal bone, not penetrating the skull. A large clot of blood existed between the layers of the arachnoid membrane, occupying the whole surface of the left hemisphere; the clot had evidently been there for some time, because it was partially invested with a false membrane. No large vessel was ruptured; there had probably been an escape of blood at different times, and this would explain the intermittent nature of the symptoms. The clot amounted to at least two fluid ounces, and the surface of the brain had been obviously indented by its pressure. Another clot of old standing was found in the Pons Varolii. The witnesses concurred in attributing death to the effusion of blood on the brain, and the effusion to the

violence inflicted by the prisoner, although it was admitted to be probable that some additional effusion had taken place just before the last fatal recurrence of symptoms. The prisoner was convicted of manslaughter. The fact that the deceased had been healthy previous to the violence, and that after this he had constantly suffered more or less from symptoms of pressure on the brain, fully justified the medical opinion, in spite of the protracted nature of the case. There was no other cause but the violence to account for the effusion and death.

Date of effusions.—Recent effusions of blood are recognized by their red colour, and the consistency and appearance of the clot or coagulum. After some days the clots acquire a chocolate or brown colour, and this passes gradually into an ochreous tint, which may be met with in from twelve to twenty-five days after the violence (see cases by Dr. Wilks, *ante*, p. 620). Coagula of effused blood also undergo changes in structure and consistency; when old they are firmer, and there is much lymph, which is sometimes disposed in membranous layers of a fibrous structure, and these are adherent to the dura mater and the brain. The surface of this organ sometimes presents a mark indicative of pressure.

The influence of time and surface in altering the appearance of effused blood, will be evident from the following case reported by the late Dr. J. Reid ('Physiological Researches,' p. 513.) A woman, æt. 70, threw herself from a window. The fall produced a severe lacerated wound of the scalp, laying bare the skull, and causing a simple fracture of the chest-bone (sternum) and leg (tibia). She died thirty-one days after the injury, in a state of exhaustion. On inspection there was a fracture of the left parietal bone, and between the dura mater and inner surface of the skull, near the left temple, there was a layer of coagulated blood, one-sixth of an inch in thickness and about two inches in breadth. In one place the coagulum had a *brownish* hue, but the greater part of it was still rather dark-coloured. On the right side there was a similar effusion of coagulated blood, but this was inside the dura mater and on the arachnoid covering of the brain (see fig. 127, p. 629), or within the cavity of the arachnoid. This coagulum was everywhere of a *chocolate-brown* colour, showing that the process of absorption was much more advanced than on the left side. A large quantity of coagulated blood had been effused into the cellular tissue near the fracture of the large bone of the leg. This was still black, and had the appearance of a recent effusion. A small quantity of black blood was also found near the chest-bone, which had been fractured. The fractured ends of the bones had been firmly united. There is no doubt that all these effusions had taken place at the same time from the same accident, *i.e.* thirty-one days before death, yet they presented very different appearances; and but for the facts being known, it might have been contended that the effusion on the arachnoid from the great change of colour was of much older date than the others. The difference, however, was probably owing to absorption being more active in the inner surface of the serous membrane than in the other structures in which blood was effused. In estimating time, as indicated by change of colour in the clot, we must therefore always consider the seat of the effusion and the absorbing power of the tissues. Dr. Reid also mentions a remarkable case of effusion of serum in the ventricles of the brain in the case of a young man, who died about a week after he had received a blow on the right side of the face. It appeared, however, that he had sustained a severe injury to the head eighteen months before, and certain changes in the brain, as well as the appearance of the effusion, rendered it probable that it was really of old date, and that it had been caused by the first accident and not by the blow on the face. (Op. cit. p. 517.)

When a medical man is required to give an opinion of the *date* of an effusion found on the brain, great caution is required. A surgeon may not be able to

rise to the apprehension of fatal consequences, and the co-existence of a mark of violence on the head might lead to error in the formation of an opinion. What is the line of conduct to be pursued on such occasions? The examiner should weigh all the circumstances, and if there be one cause for the symptoms more probable than another, he should adopt it: if there be any doubt, this should be stated to the Court.

There is nothing in the state of the brain in a dead body, which will enable a practitioner to distinguish whether concussion or intoxication had existed and had been the cause of the symptoms. The vessels may be congested in both cases. The discovery of alcoholic liquid in the stomach may lead to a presumption that deceased had been intoxicated, while marks of violence on the head may favour the view that he had suffered from concussion. When both conditions are found, the examination of the body cannot lead to a solution of the question. The answer must then depend on the special circumstances proved, and, if procurable, on the nature of the symptoms preceding death.

It is to be feared that medical witnesses are not sufficiently careful on these occasions to determine whether there are signs of intoxication about an injured person. Subsequent proceedings may render this a material part of the inquiry. In November 1851, the house-surgeon of a London hospital was severely reprimanded by a magistrate, in consequence of an omission to inquire and satisfy himself whether, in addition to the results of violence, a policeman who was brought to the hospital was or was not intoxicated when admitted. The question was of importance; the injuries to the head might have arisen from a fall, and a drunken man might readily meet with such injuries from accident. A person was charged with an assault on the policeman, but upon very suspicious evidence; and, in fact, could intoxication have been proved or rendered probable, there would have been no ground for the charge. The medical man had already certified that the patient was not intoxicated, but when pressed in cross-examination could not say whether he was or was not. The case was immediately dismissed. There can be no excuse for not making a full inquiry into the precise condition of an injured person, and arriving at the best judgment of which the case admits. A state of intoxication often renders it difficult to form an accurate opinion in a case of alleged criminal wounding; but it is always in the power of a witness to satisfy himself by close examination, the use of the stomach-pump, or simply watching the patient, whether he is in a state of drunkenness or whether he is labouring under the effects of disease or violence. In more than one instance within a recent period persons who have been struck with incipient symptoms of apoplexy in the street have been seized and locked up as drunk, and have soon afterwards been found dead or dying! Others, who have suffered from violence, have perished from neglect under a similar mistake made by a medical man or by the police. Disease of the brain as well as injuries to the brain from violence, may give to a man a staggering gait and render him helpless: they are also commonly accompanied by stupefaction and vomiting. If it should happen that shortly before such an attack, the person has taken beer, wine, or spirits, sufficient to give an alcoholic odour either to the breath or the matter vomited, it is at once treated as a case of drunkenness, and the unfortunate person is left to his fate. The death of a Mr. *King*, in London, October 1864, furnishes an instance of the necessity of a more rigorous examination of the facts on these occasions. He was pronounced by a medical man to be labouring under drunkenness, and handed over to the police. When examined by another surgeon the next morning, it was found that his skull was fractured, and that he was otherwise severely injured. He died from the effects. Two other cases of a similar kind occurred in London in the spring of 1872. A man who was stupified from the effects of accidental violence to the head, was sent away from a public hospital as drunk and unfit

for admission! The man died the next day, and on inspection it was found that there was a fracture of the base of the skull, with great effusion of blood. It appeared that some brandy had been given to deceased soon after the accident to rouse him, and the smell of this in the breath had probably thrown the house-surgeon off his guard. It was alleged in explanation that there was no mark of external violence, and the man appeared only stupified and unable to stand. Medical diagnosis was here greatly at fault from causes easily to be appreciated.

The distinction of apoplexy from drunkenness involves greater difficulties. In these cases we have to deal with the true diagnosis of alcoholic or narcotic poisoning (p. 384). Dr. Jackson has directed attention to this medical question in a case reported in the 'Med. Times and Gaz.,' 1871, 1, 360. Some instructive cases, in reference to this complication of wounds, have been published by M. Tardieu. (See 'Med. Gaz.,' vol. 44, p. 347.)

Extravasation or effusion of blood.—A blow on the head may destroy life by causing an effusion of blood either on the surface or in the substance of the brain. In pugilistic combats, when a person is thus struck, he commonly falls, and death may take place in a few minutes. On inspection, blood may be found effused either at the base or in the ventricles of the brain, and the question will present itself—Did the injury which caused death arise from *a blow or a fall?* Two cases of this description are reported by Dr. Wharrie. The men were knocked down by blows with the fist, and they were taken up dead. (Cormack's 'Monthly Jour.' Feb. 1846, p. 117.) It is not easy to give an answer to this question, and its relevancy in a legal view is not apparent; for as it is presumed the blow was the cause of the fall, it follows from recent decisions that the assailant would be responsible for the effects of either or both. In a case of this kind (*Reg.* v *Williams*, Denbigh Lent Assizes, 1856), in which deceased had received a blow and sustained a fall, and his death was clearly proved to have resulted from the violence, the judge directed the jury, if the death was caused by 'the fighting,' to return a verdict against the prisoners. They, however, according to the usual practice of Welsh juries, persisted in returning a verdict of not guilty, assuming that the fatal injury was caused by the fall and not by the blow! A heavy blow on the head may cause at once fatal effusion of blood, but in these instances the effusion commonly arises from the violent concussion which the injured person sustains by the fall. A medical witness will therefore in general be compelled to admit that the fatal effusion might have taken place either from a blow or a fall. If the fall has resulted from accident and not from a blow, this will, of course, absolve the accused from responsibility for the fatal results.

This subject has important applications in legal medicine, for this is one of the most common causes of death from injuries to the head, and there are generally many cases of this description tried at the assizes. Effusion may occur from violence, with or without fracture, and it may take place without being accompanied by any external marks of injury. In the case of *The Queen* v. *Phelps* and others (Gloucester Autumn Assizes, 1841), it was proved that there was great effusion of blood, and even laceration of the brain, without corresponding external injuries on the deceased. (See also at the same Assizes, the case of *The Queen* v. *Thomas.*) The late Dr. Griffiths, the American editor of a former work, mentions a case which was the subject of a trial at Massachusetts, in which a person received a blow from a small stone, and died in ten minutes. On examination there was no external bruise or fracture of the bones: the ventricles were filled with coagulated blood, and all the vessels were gorged with blood. It was observed that the skull was in this instance unusually thin (p. 287, Amer. edit.). The chief source of the effusion in violence to the head arises from a rupture of the meningeal artery, and this may

occur from a mere shock or concussion, with or without a fracture of its bony canal. The blood thus effused acts by compressing the brain; this compression does not always cause death unless the blood is in large quantity, or unless it is effused in or around the base of the brain (medulla oblongata). Thus the hemispheres will bear a degree of compression from blood which, if it affected that portion of the base of the brain from which the spinal marrow proceeds, would instantly destroy life. The most fatal effusions, therefore, are those which take place in a fracture of the base of the skull, whereby one or both lateral sinuses are commonly ruptured. There may, however, be laceration of the brain, with effusion of blood to some extent at the base, and yet the person may survive some days. Dr. Paterson, of Edinburgh, communicated to me a case which occurred in February 1854, in which a woman survived for a period of twelve days, severe injuries to the head supposed to have been inflicted by her husband. She was insensible during the whole of this time; some of the external marks of violence had nearly disappeared, and undergone the usual changes of colour. A severe blow had obviously been inflicted on the summit of the head. On inspection after death it was found that there had been laceration of the brain by counter-stroke, and a large clot of blood was observed to occupy the lacerated part, extending over the surface of the base of the brain and into the ventricles. In this instance the woman survived a severe injury for an unusually long period. In the case of *Cuming* (Edinburgh, Dec. 1853), the deceased, the wife of the prisoner, died on November 8, from laceration of the brain produced by blows on the head, inflicted by the prisoner on October 26. The woman lay in a state of insensibility during the whole period of thirteen days. In a case admitted into Guy's Hospital, July 1856, death, as a result of effusion of blood, from injury to the head, did not take place until the twelfth day. The patient, æt. 18, received a blow on the head during a fight. He did not suffer much in consequence, and continued his employment during the next ten days, but on the eleventh day, owing to his having head-ache, he came to the hospital. He walked to his bed, and appeared quite rational, but he was depressed, and there were febrile symptoms. He died during the night. Dr. Wilks, who reports this case, found on inspection bruises on the arms, but the head presented no outward sign of injury, and the bones were not fractured. On removing the outer membrane (dura mater) the right half of the brain was surrounded by effused blood which had compressed it. It was contained in the cavity of the arachnoid membrane. The brain presented no breach of surface or laceration from which the blood could have issued, and its substance was healthy. Four ounces of blood in a fluid state were collected. There was a loose coagulum of a slightly brown hue, and under this there were other coagula of a light ochreous colour adherent to the brain and dura mater, showing that the blood had been effused some days. These coagula were in membranous layers, and under the microscope presented a fibrous texture. ('Guy's Hospital Reports,' 1859, 5, 123.) This case shows the insidious nature of injuries to the head, and that an injury may prove fatal without leaving any marks of violence externally, or appearance of laceration of vessels or brain-substance internally. A man while intoxicated was thrown down, and struck his head against the pavement. He was taken up insensible, the wound was dressed, and he partially recovered his senses. Three days afterwards he was brought into Guy's Hospital in a state resembling that of concussion. There was a scalp-wound at the back of the head on the left side. He remained in a lethargic state, being occasionally affected with fits of convulsions. About a week after his admission he sank into a half comatose state, and occasionally screamed out. The pupils became finally contracted (as in narcotic poisoning), and he died on November 15, *twenty-five days* after the infliction of

the violence. Dr. Wilks found, on inspection, a layer of blood an inch thick covering the right hemisphere of the brain. The clot was thready, of a dull red-colour, and in some parts of a yellow or ochreous tint, showing from these changes in the red colouring matter that the blood had been effused for a considerable time. On two portions of the base this yellow clot was closely adherent to the brain, and on removing it this was found to be bruised and softened. The source of the blood was traced to some ruptured vessels of the inner membrane (pia mater) at this spot. None of the larger arteries or venous sinuses were found injured, and there were no inflammatory products. ('Guy's Hospital Reports,' 1859, 5, 122.)

In cases of injuries to the head proving fatal by *effusion* of blood on the brain, a person may recover from the first effects of the violence, and apparently be going on well, when he will suddenly become worse, and die. Effusion takes place slowly at first,—it may be arrested by the effects of stupor from concussion, by a portion of the blood coagulating around the ruptured orifices of the vessels, or by some other mechanical impediment to its escape; but after a longer or shorter period, especially if the person be excited or disturbed, the bleeding will recur and destroy life by producing compression. How many hours or days are required in order that such an increased effusion should take place after an accident, it is impossible to say; but in severe cases, it is generally observed to follow the injury within a short time. Sir Astley Cooper has related the case of a gentleman who was thrown out of a chaise, and fell upon his head with such violence as to stun him in the first instance. After a short time he recovered his senses, and felt so much better that he entered the chaise again, and was driven to his father's house by a companion. He attempted to pass off the accident as of a trivial nature, but he soon began to feel heavy and drowsy, so that he was obliged to go to bed. His symptoms became more alarming, and he died in about an hour, as it afterwards appeared, from effusion of blood on the brain. When the brain has sustained laceration from violence, in addition to insensibility, convulsions are frequently observed.

Effusion of blood from disease or violence.—Blood may be found effused in various situations within the interior of the skull, and the cause of the effusion may be either disease or violence. The skill of a medical jurist is often required to determine which of these causes is the more probable, as where, for instance, a pugilist has died, after having received severe injuries to the head, and his adversary is tried on a charge of manslaughter. On these occasions it is often urged in the defence, that the bleeding might have arisen either from a diseased state of the vessels of the brain, or—if the evidence render it probable that the blow was the cause—that the effects of the blow were aggravated by a diseased condition of the vessels, or by the excitement into which the deceased was thrown, either from the effects of intoxication or passion. When the brain is not lacerated by violence, the blood is effused either on the surface of the hemispheres, between the membranes, or at the base. When the effusion is caused by violence, the effused blood is not always found under the spot where the blow was inflicted, but occasionally by counter-stroke on the surface of the brain, directly opposite to it—a case which a medical witness has frequently been required to explain on trials, and which depends on the same cause as fracture by counter-stroke, *i. e.* on a separation of parts (laceration of the brain, effusion of blood, or even fracture of the bones) at the point of the skull directly opposite to that which sustains the violence. Dr. Paterson's case above related (p. 620) furnishes a good instance of extensive injury by counter-stroke. A severe blow had been inflicted on the summit of the head, as the mark was plainly visible, but the fatal injury was found in the base of the brain, *i. e.* on the part opposite to

that which received the blow. Hence the brain was lacerated and blood effused. Again, fracture of the base of the skull is frequently the result of severe violence applied to the top of the head (vertex). (See case by Dr. Haworth. 'Med Gaz.,' vol. 36, p. 368.) Effusions of blood from a diseased state of the vessels more commonly take place in the substance of the brain, but they sometimes occur on the surface of the organ as a result of mere excitement or over-exertion of the muscular powers. A diseased condition of the vessels, and probably a softening of the substance of the brain, will on these occasions be apparent on inspection.

In a case which occurred in 1840, a boy, aged twelve, died suddenly with comatose symptoms, after violent exertion. On inspection, half a pint of blood was found effused on the surface of the brain. ('Lancet,' Nov. 1840.) This case is the more remarkable, because it is rare that a spontaneous effusion from disease should occur in so young a person. Then again it must be remembered that, under the effects of violence when the brain participates in the injury, blood may be effused in its substance so as to resemble cerebral hæmorrhage from disease. Thus when the skull has sustained violent blows without fracture, the extravasated blood has been observed to proceed from the minute vessels of the pia mater and choroid plexus. A singular case is reported ('Lancet,' Jan. 11, 1845, p. 51), where a blow on the neck over the jugular vein caused instantaneous death, apparently from effusion of blood in the brain. Another fatal case from the same cause is referred to, in which a large quantity of blood was found effused in the lateral ventricles. Dr. Traill mentions an instance which occurred at Liverpool in 1838, in which a blow with the naked fist entirely divided the external carotid artery in a healthy man, who died very speedily. ('Outlines,' p. 89.)

If the effusion depend on *disease*, the arteries around may be found in a diseased condition, or the brain itself may be found softened and disorganized. The state of the brain and its vessels should be closely examined in all cases of alleged violence, since hæmorrhage may take place either from excitement or slight blows, whenever this diseased condition exists. It has occasionally happened, especially in old persons, that the person has dropped down dead without a blow being struck, and that death has been wrongly imputed to violence. Cerebral hæmorrhage from disease rarely occurs in persons under forty years of age. Frequent intemperance and violent passion may, however, easily create a tendency to it in younger subjects. As an effect of violence it may take place in persons of all ages, but when the marks of violence are slight, a witness must exercise great caution before he alleges that the extravasation was produced by a blow, especially when it is found that the deceased was of intemperate habits. For a very full account of the circumstances accompanying extravasation from violence, see Brach's 'Chirurgia Forensis Specialis,' p. 63, Köln, 1843.

Another condition besides intoxication and passion has been said to favour a rupture of vessels and an effusion of blood on the brain—namely a thickened state of the substance of the left ventricle of the heart. According to some pathologists, this morbid condition favours the occurrence of cerebral hæmorrhage by the force with which the ventricle propels the blood to the brain. Unless the brain is softened and the vessels are diseased, it is, however, doubtful whether this condition of the heart would have any influence. A case was tried at the Central Criminal Court (Aug. 1836, *Reg.* v. *Brown*), in which the prisoner owed his acquittal entirely to the deposition of the medical witness as to the condition of the heart. It was proved that the deceased had been much maltreated by the prisoner about the face and head, and that he speedily died, to all appearance, from the violence. On inspection, the medical witness stated that he found the left ventricle of the heart considerably thickened and

dilated, and that under excitement this morbid condition had probably led to the effusion of blood on the brain, and death. Upon this evidence Baron Gurney directed an acquittal.

As a summary of these remarks, we may say that in effusions of blood from violence, the blood generally issues from a vessel which is plainly seen to be torn, as the middle artery of the brain or the lateral sinus; it is commonly found on the surface of the brain, and not in its substance, unless the organ is lacerated. When the blood is effused between the dura mater and skull, more especially when immediately below the seat of violence or directly opposite to it by counterstroke, this is strong evidence, *cæteris paribus*, that it has proceeded from a blow. When there is a fracture of the skull, the presumption of the extravasation being due to violence is great; because this is not only a sufficient but a very obvious cause, while the idea of its having proceeded from disease only is remote and speculative. When, besides these conditions, there is no remarkable congestion of the brain in other spots, the substance of the organ is firm, and the vessels are to all appearance free from disease, we have the strongest reason to believe that the effusion must have been due to violence, and to no other cause whatever. At the trial of *Edey* (High Court of Justiciary, Edinburgh, Nov. 1847), it was proved that the deceased had died from effusion of blood on the brain, and the question was, whether this had arisen from a blow or from disease. The medical witness deposed that he found no marks of disease in the blood-vessels of the brain, and his opinion was that it had resulted from violence. The prisoner was convicted. A case of some interest in relation to this question was communicated to the 'Lancet' by Mr. H. Kyd (Nov. 13, 1847, p. 521). An effusion of blood which led to sudden death after a blow on the mouth during a pugilistic encounter, was however in this instance considered to have arisen from excitement.

The evidence given on some trials, when the main question has turned upon the *cause* of an effusion of blood in the case of a person who has sustained violent injuries to the head, has rather tended to reflect disgrace on medical science. It has been made to appear from the mouth of the medical witness, either directly or by implication, that no sort of mechanical violence applied to the head of a man in a state of drunkenness or passion—of one whose cerebral vessels were probably diseased—or the substance of whose heart might be thickened—could have had any effect in producing a fatal extravasation found in the head after death. In spite of an individual having received a violent blow with a bludgeon, sufficient to have killed a stout and vigorous man, or of his having been thrown with considerable force with his head against a stone-floor, an unqualified admission is often made, that excitement alone, or drunkenness alone, would account for the extravasation without reference to the blow. In putting the most favourable construction upon these cases, when we have clear evidence of great violence having been used to the head, with the presence of the usual post-mortem appearances, our opinion should be that the excitement or drunkenness might have predisposed to, but was not the immediate cause of, the cerebral hæmorrhage. There seems to be no good reason for assuming that apoplexy from natural causes always occurs, by a peculiar coincidence, just at the time that a person receives a violent blow with a bludgeon on the head, or for giving to the assailant the benefit of this hypothetical explanation!

A mere inspection of the body does not always lead to the discovery of the cause of an effusion on the brain. The violence causing an effusion of blood may have been slight, and unless attention is particularly directed to the subject, it may be overlooked. In the case of a woman who died in a London hospital in August 1857, there was no fracture of the skull or external injury to account for effusion of blood on the brain. The brain was not injured,

and in fact there was no apparent cause of death but the effusion, and this was somewhat precipitately assigned to disease. A certificate of death from 'apoplexy' was given, and the deceased was buried. It subsequently transpired that she had been maltreated by her husband, and that the effusion of blood was owing to this maltreatment! The condition of the effused blood should be accurately noticed, in order to determine whether it presents any marks indicative of its being recent or of old standing.

Spontaneous effusions or effusions from disease are not easily distinguished from those which are the result of violence to the head. Dr. Wilks has pointed out that in most instances of *severe* injury attended with effusions of blood, the structure of the brain is found bruised. In meningeal apoplexy (apoplexy of the membranes) the source of the blood is a vein of the pia mater or inner membrane, and sometimes a large arterial trunk. The difficulty chiefly arises in those cases in which effusion is found after slight violence, and there is, at the same time, disease of the blood-vessels of the brain. Dr. Wilks gives the result of several inspections in which effusion was owing to disease—to violence, and to a mixed condition. (See 'Guy's Hospital Reports,' 1859, p. 120.)

Effusion of blood from excitement.—When engaged in the investigation of these cases, it is always a fair matter of inquiry whether the *violence* upon the evidence was not of itself sufficiently great to account for the effusion without the supposition of coexisting disease or excitement. Admitting that the rupture of a blood-vessel, and the effusion of blood on the brain, may take place from simple excitement and passion, yet this is an event comparatively rare, at least in the young and healthy, while nothing is more common than that these results should follow violent injuries to the head, whatever the age or condition of the person. When the person assaulted is of intemperate habits and advanced in life, and the violence is not adequate to account for the effusion in a healthy person, it may be fairly assigned to excitement or disease. In *Reg.* v. *Portbury* (C.C.C., March 1872) a woman was charged with the murder of her mother. Deceased died ten days after a quarrel with the prisoner. On inspection there was congestion of the membranes of the brain, with slight effusion. There was nothing to indicate that this had been caused by violence, and the effusion, which was the cause of death, might have arisen from excitement, considering the age and habits of the deceased. This view was adopted by the jury, and the prisoner was discharged. A case occurred in London, in August 1865, of a similar kind, but death was more rapid. The deceased, æt. 55, had presided at a meeting, and was engaged in an angry altercation, when he received a sharp blow on the cheek. He leaned over on his right side, but did not speak. He died in ten minutes. Both deceased and the assailant were greatly excited. On inspection blood was found effused on the brain. The medical man properly referred death to apoplexy, as the result of excitement and not of the blow which was struck.

If on these occasions a medical witness is unable to state positively whether the effusion was due to the excitement or the blows, he will satisfy the Court if he only states clearly that which is, in his own mind, the more probable cause of death; and by weighing all the circumstances of the case beforehand, he will rarely fail to find that one cause was more probable than the other. Thus, if a man, excited by passion and intoxication, is struck on the head, and the blow is slight—such as an unaffected person would probably have sustained without injury—yet in this case insensibility and death follow, and, on examination, a quantity of blood is found effused in the substance of the brain, can it be a matter of doubt, medically speaking, that the effusion was chiefly due to the excitement under which the deceased was labouring? To take a converse instance—a man engaged in a personal conflict with another, is struck most violently on the head, or falls with great force on that part of his body:

on inspection it is found that death has arisen from effusion of blood on the surface of the brain, and it would be no unexpected consequence of the violence inflicted that a similar appearance should be met with in an individual calm and unexcited. Could a practitioner hesitate to say, under these circumstances, that the blow would satisfactorily account for the effusion, without reference to any coexisting causes of excitement? These may be allowed to have their influence, in giving an increased tendency to cerebral hæmorrhage, or in aggravating the consequences of the blow, but no further.

In these criminal investigations, when a witness is examined in chief, he asserts, perhaps, that the extravasation of blood was owing to a blow inflicted on the head. He is then asked by the counsel who cross-examines him, whether vessels may not be ruptured by excitement: he answers, without any qualification, in the affirmative, and thus produces an impression on the minds of the jury that excitement may have caused the rupture of the vessel in the particular case on which he is being examined. This is, of course, the sort of answer which a prisoner's counsel wishes to extract from a medical witness; and the effect produced by it on the Court is not always removed, even by a careful re-examination. The counsel for the defence is well aware that in a case of this description his only chance of obtaining an acquittal is to throw a degree of doubt on the medical evidence, and to render it probable to a jury that the death of the deceased was due to some other cause than the blow inflicted by the prisoner. It may be very proper that a skilful barrister should exercise his talents in this way, but a medical witness has to remember that he is sworn to state the *whole* truth. A qualified answer should be given to what is really a general question; and supposing his opinion to be already formed on the subject on which his evidence is required, he should not, unless it be strictly consistent with his own views, allow his answer to a *general* question to be made applicable to a *particular* case. If, then, asked, in cross-examination, whether vessels might not be ruptured, and blood extravasated by mere *excitement*, he should answer that such an effect might undoubtedly follow; but that it was his opinion—and I am here supposing that his opinion has been founded upon a deliberate examination of all the *medical* facts—that excitement was not the cause of rupture and extravasation in the case in question. A witness has, it appears to me, a right to insist that his evidence shall pass to the jury without having any designed ambiguity attached to it. It may be said that the remedy for an evil of this kind is the re-examination of the witness; but I am satisfied, from the reports of many cases before me, that the point is overlooked. Besides one cannot understand why a piece of sophistry and equivocation is to be left to a chance exposure:—the case would then rest not upon sound medical evidence, but upon the relative degree of ingenuity and ability displayed by the counsel for the prosecution and defence. In a trial for manslaughter which took place some years since at Derby, it was proved that the prisoner and deceased had been wrestling. The prisoner had thrown the deceased with his head on a stone floor; he then seized him by the throat, and beat his head several times against the floor. The deceased died nineteen hours afterwards. On inspecting the body, a great quantity of coagulated blood was found beneath the scalp. There was a wound over the right parietal bone, an inch and a half in length, penetrating through the scalp, but no fracture of the skull. There was a quantity of extravasated blood on the opposite or left side of the head, and a rupture of some branches of the carotid artery on the inside of the skull. On the neck were two discolorations to the left of the windpipe, apparently ocasioned by the pressure of two fingers. The laying hold of the neck might, in the opinion of the witness, have more readily caused a rupture of the cerebral vessels, by preventing the return of blood. The surgeon, after giving this description of the post-mortem appear-

ances, was asked whether, in his opinion, death was occasioned by the injury proved in evidence. He said death might or might not have been occasioned by it. Death might have arisen from other causes—an apoplectic fit might have caused it. The effusion of blood was the immediate cause of death, and he had seen blood in the heads of many persons dying from apoplexy. He was not able to speak to the cause of the rupture of the vessels. He thought it highly probable that the injury received was the cause of death—it was certainly sufficient to account for it! It is not mentioned whether the man was found guilty upon this loose evidence, or whether the jury acquitted him. ('Med. Gaz.' vol. 7, p. 382.)

A case was tried at the Gloucester Summer Assizes, 1845 (*Reg.* v. *Phipps*), in which a strong opinion was expressed by Mr. Justice Patteson, in relation to the defence frequently adopted on these occasions. During a fight, the prisoner struck the deceased a severe blow under the left ear. He fell and died in a few minutes. After death, blood was found extravasated on the part corresponding to the seat of violence, and this, in the opinion of the medical witness, satisfactorily accounted for death. The defence was, that the effusion might have proceeded from over-excitement; but the judge is reported to have said that if it were proved two people were fighting together—blows were struck—one fell to the ground and died, and afterwards internal injuries were found corresponding with the external marks of violence, no power on earth could persuade him that such blows were not the cause of death! The prisoner was found guilty.

Effusion of blood causing death after a long period of time.—Admitting that blood has been effused on the brain as a result of violence, the person injured may survive the effects for so long a period as to create a legal doubt whether death can be strictly assigned to the violence. In this respect the case of *Reg.* v. *Sullivan* (C. C. C. Sept. 1853) is of some interest. The late Dr. M'William, who gave evidence at the trial, gave me the particulars of this case. Deceased, a healthy man, was knocked down by the prisoner, and fell with his head upon the ground. He appeared as if he was stunned, and staggered in attempting to walk: he complained of pain in the head and general weakness. This was on the 11th of April 1853. Although he suffered from pain in the head, he had no medical advice until the 12th of May, and had in the meantime performed his duties as an officer of the Customs. After this he suffered from dimness of sight, and became delirious. On the 29th he came under the care of Dr. M'William. There were marks of bruises on the head, there was impairment of vision, a faltering gait, and other symptoms indicative of pressure on the brain. He improved under treatment, but the symptoms returned in an aggravated form about the 12th of June; he became insane, and was transferred to St. Luke's Hospital. Dr. Stevens, under whose care he was then placed, stated that he had delusions, and was evidently suffering from pressure on the brain. He recovered so far that he was about to be discharged, when the symptoms of pressure became aggravated, and death took place on the 17th of August, *i.e. four months* after the infliction of the violence. On inspection a shot was found imbedded in the frontal bone, not penetrating the skull. A large clot of blood existed between the layers of the arachnoid membrane, occupying the whole surface of the left hemisphere; the clot had evidently been there for some time, because it was partially invested with a false membrane. No large vessel was ruptured; there had probably been an escape of blood at different times, and this would explain the intermittent nature of the symptoms. The clot amounted to at least two fluid ounces, and the surface of the brain had been obviously indented by its pressure. Another clot of old standing was found in the Pons Varolii. The witnesses concurred in attributing death to the effusion of blood on the brain, and the effusion to the

violence inflicted by the prisoner, although it was admitted to be probable that some additional effusion had taken place just before the last fatal recurrence of symptoms. The prisoner was convicted of manslaughter. The fact that the deceased had been healthy previous to the violence, and that after this he had constantly suffered more or less from symptoms of pressure on the brain, fully justified the medical opinion, in spite of the protracted nature of the case. There was no other cause but the violence to account for the effusion and death.

Date of effusions.—Recent effusions of blood are recognized by their red colour, and the consistency and appearance of the clot or coagulum. After some days the clots acquire a chocolate or brown colour, and this passes gradually into an ochreous tint, which may be met with in from twelve to twenty-five days after the violence (see cases by Dr. Wilks, *ante*, p. 620). Coagula of effused blood also undergo changes in structure and consistency; when old they are firmer, and there is much lymph, which is sometimes disposed in membranous layers of a fibrous structure, and these are adherent to the dura mater and the brain. The surface of this organ sometimes presents a mark indicative of pressure.

The influence of time and surface in altering the appearance of effused blood, will be evident from the following case reported by the late Dr. J. Reid ('Physiological Researches,' p. 513.) A woman, æt. 70, threw herself from a window. The fall produced a severe lacerated wound of the scalp, laying bare the skull, and causing a simple fracture of the chest-bone (sternum) and leg (tibia). She died thirty-one days after the injury, in a state of exhaustion. On inspection there was a fracture of the left parietal bone, and between the dura mater and inner surface of the skull, near the left temple, there was a layer of coagulated blood, one-sixth of an inch in thickness and about two inches in breadth. In one place the coagulum had a *brownish* hue, but the greater part of it was still rather dark-coloured. On the right side there was a similar effusion of coagulated blood, but this was inside the dura mater and on the arachnoid covering of the brain (see fig. 127, p. 629), or within the cavity of the arachnoid. This coagulum was everywhere of a *chocolate-brown* colour, showing that the process of absorption was much more advanced than on the left side. A large quantity of coagulated blood had been effused into the cellular tissue near the fracture of the large bone of the leg. This was still black, and had the appearance of a recent effusion. A small quantity of black blood was also found near the chest-bone, which had been fractured. The fractured ends of the bones had been firmly united. There is no doubt that all these effusions had taken place at the same time from the same accident, *i.e.* thirty-one days before death, yet they presented very different appearances; and but for the facts being known, it might have been contended that the effusion on the arachnoid from the great change of colour was of much older date than the others. The difference, however, was probably owing to absorption being more active in the inner surface of the serous membrane than in the other structures in which blood was effused. In estimating time, as indicated by change of colour in the clot, we must therefore always consider the seat of the effusion and the absorbing power of the tissues. Dr. Reid also mentions a remarkable case of effusion of serum in the ventricles of the brain in the case of a young man, who died about a week after he had received a blow on the right side of the face. It appeared, however, that he had sustained a severe injury to the head eighteen months before, and certain changes in the brain, as well as the appearance of the effusion, rendered it probable that it was really of old date, and that it had been caused by the first accident and not by the blow on the face. (Op. cit. p. 517.)

When a medical man is required to give an opinion of the *date* of an effusion found on the brain, great caution is required. A surgeon may not be able to

fix the precise date, but it may be in his power to say whether the blood has been effused for a few days, weeks, or months. Mr. Greaves, of Derby, consulted me on a case which was tried at the Derby Lent Assizes, 1859, in which this question was material. On the 25th of January a man was kicked violently on the head by two companions. He was attended by a surgeon for fourteen days, and he was then pronounced to be convalescent. On the 6th of March, six weeks after the assault, the man became seriously ill, and he died on the 11th of March. The two men were tried for manslaughter; and at the trial a medical man deposed that the deceased died from the effects of the injuries inflicted by the prisoners on the 25th of January. The post-mortem appearances were, congestion of the brain, with effusion of a large clot of blood on the surface of the left hemisphere, immediately below the situation of the most serious external wound, this clot being surrounded by a considerable quantity of coagulable lymph. The prisoner's counsel then put the question to the witness: 'I can produce evidence to show that deceased fell down some steps into a cellar, upon his head, three weeks before his death—do you not think it more likely that death was the result of this fall, rather than of the beating three weeks prior to the fall?' The surgeon at once said: 'Certainly not;' and continued, 'there could not have been the effusion of lymph I describe after an accident within so short a space of time as three weeks. There must have been a longer space of time between the injury and the death to have produced this appearance.' The reasons for so strong an opinion were not extracted in cross-examination, or it might have transpired that the witness had not seen any case to justify it. So far as the description goes, there was nothing to show that the effusion had been there more than three weeks. Coagulable lymph may be found in these effusions within a much shorter period than three weeks, as the following case, which occurred to Mr. Greaves, will prove. A man fell from a height upon his head, was ill for three days, and then so far recovered that he sat up and dressed himself; on the next day he became insensible, and died on the eighth day after the accident. On inspection, the base of the skull was found fractured, the fracture including both orbits; there was effusion with much lymph at the base of the brain. In the case which was the subject of trial, the situation of the effusion beneath the seat of violence was in favour of its being caused by that violence, but there was nothing in the appearance of the effusion to enable a medical man to say whether it had taken place either six weeks or three weeks before death. The perfect intermediate recovery was somewhat adverse to the theory that the clot was produced by the violence of the prisoners.

When the force is of a bruising kind, the whole substance of the skull may be fractured without a division of the skin (*The Queen* v. *Ward*, Cent. Crim. Court, 1841). There is one remarkable circumstance connected with fractures accompanied by depression of bone, which here requires to be mentioned—namely, that the person has been sensible so long as the foreign substance which produced the fracture and depression remained wedged in the brain, and that insensibility and other fatal symptoms began to manifest themselves only after its removal. This being admitted, it may be urged in defence, that death was really caused by medical interference. But it is a sufficient answer to state, that the wounded person must have died from inflammation of the brain if the foreign body had been allowed to remain; and that it is consistent with the soundest principles of practice to remove all such foreign substances without delay. In fractures of the skull, with depression, it may become a question whether the surgeon raised the depressed portion of bone so soon as he ought to have done. (See case, Henke, 'Zeitschrift der S. A.' 1838. 'Erg. H.' 230.) A blow on the head may produce a fracture of the inner table of the skull and cause death by compression as a result of the fracture or of the effusion of blood.

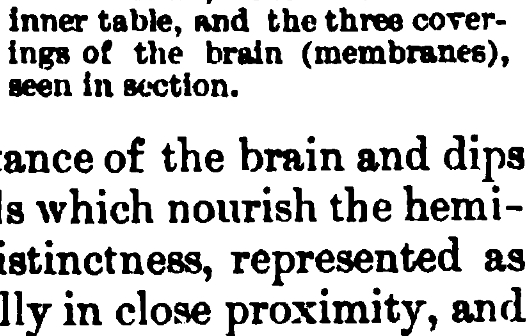
In *Reg.* v. *Hadwen* (Lancaster Aut. Ass. 1871), prisoner struck a boy a severe blow on the head. He became sick and unconscious, fell into a state of collapse, and died the next day. On inspection the inner table of the skull (see fig. 127, *a*) was found to be fractured, and there was effusion of blood on the brain.

Wounds of the brain.—Wounds of the brain sometimes prove instantaneously mortal, even when slight, while in other cases recoveries take place from contused or punctured wounds of this organ, contrary to all expectation. When a person survives the first effects of the injury, there are two sources of danger which await him: 1. The production of fungus from the exposed portion of the brain; and 2. Inflammation and its consequences. The process of inflammation, it must be remembered, is very slowly established in this organ; it may not manifest itself until from three to ten weeks after the injury. In one remarkable case, where a child was accidentally shot through the brain, the ball having traversed both hemispheres, no symptoms of cerebral inflammation manifested themselves for twenty-six days. The child died on the twenty-ninth day. ('Med. Gaz.' vol. 39, p. 41.)

In the description of injuries of the head, it is impossible to avoid the use of terms with which members of the legal profession are not likely to be acquainted. In giving evidence upon the situation of wounds, of the effusion of blood, and the effects of fractures, medical witnesses are often compelled to make use of anatomical terms, and are not always successful in explaining them. With the view of removing this difficulty, and supplying, to some extent, the means of following the evidence of a witness in his description of injuries to the head and its contents, some engravings of the brain and its membranes are annexed.

Fig. 127 represents a section of the bones of the skull, with the three membranes which cover the brain. (*a*) Section of the skull-bones, with the outer and inner tables, and the intermediate cellular structure or diploe, indicated by the dark shading; the scalp, or skin of the skull, which covers the outer table, is not represented. (*b*) The dura mater, or outer membrane of the brain; it is thick and fibrous, closely adherent to the inside of the inner table of the skull, but smooth on the side towards the brain. (*c*) The tunica arachnoides, so named from its delicate web-like structure, smooth towards the dura mater, but closely covering the pia mater beneath. (*d*) The pia mater—the membrane which immediately invests the substance of the brain and dips into all the convolutions. It contains the blood-vessels which nourish the hemisphere of the brain. These membranes are, for distinctness, represented as being separated from each other, but they are naturally in close proximity, and the rough side of the dura mater is closely adherent to the inside of the skull (calvarium). The ordinary seats of the effusion of blood from violence are between the dura mater and inner table of the skull, and between the pia mater and the surface, or in the substance of the brain.

Fig. 127.



The skull, with its outer and inner table, and the three coverings of the brain (membranes), seen in section.

Fig. 128 represents a horizontal section of the brain from front to back. 1, 1, the two *hemispheres* cut down, forming what is called the *centrum ovale*. The greater part of this consists of white medullary or brain substances, studded with small red points (the sections of small blood-vessels) called *puncta cruenta* or *vasculosa*. It is surrounded by a narrow margin, darkly shaded, which represents the grey or cineritious substance, from its having a darker colour than the mass of the brain. The depth to which the *convolutions* of the brain extend into its substance is here seen, and it is into these that the pia mater or investing

membrane dips. 2 and 3 represent in section the fore and back parts of the *corpus callosum*, or the body by which the two hemispheres are united. The removal of this has exposed the two great cavities of the brain, one in each hemisphere, called the *lateral ventricles*. These are here seen with their contents. 4. Part of the *septum lucidum*, showing a slight space between its layers, which is called the fifth ventricle. 5, 6, 7, are prolongations of the cavities or ventricles, front and back, which from their shape are called cornua (horns). 8. The *corpus striatum* of one ventricle. 9. A dark fringe-like looking body called the *choroid plexus*; it consists of a fold of membrane (pia mater) enclosing numerous blood-vessels. This plexus communicates with that of the opposite ventricle through the foramen of Monro. A bristle is passed through the opening under 4, and its extremities are seen resting on the corpus striatum on each side. 10. A portion of the *thalamus opticus* of one ventricle. 11. The fornix. 12. The hippocampus major, descending into the middle cornu.

Fig. 128.

A section of the brain, showing the centrum ovale and ventricles or cavities.

Fig. 129.

Vertical longitudinal section of the brain, cerebellum, Pons Varolii and the upper part of the spinal marrow (Hirschfeld and Leveillé).

1. Convolutions of longitudinal fissures.
4. Corpus callosum.
9. Pineal gland.
13. Corpora quadrigemina.
17. Fourth ventricle.
18. Optic nerve.
19. Arbor vitæ cerebelli.
21. Section of Medulla oblongata.
26. Section of Pons Varolii.

Wounds of the face.—When wounds of the face are of any extent they are usually followed by great deformity; and when they penetrate the cavities in which the organs of the senses are situated, they often prove fatal, either by involving the brain and its membranes, or by giving rise to inflammation of this organ. Wounds of the eyebrows are not of so simple a nature as might

at first sight be supposed. Besides being attended with deformity when they heal, they are liable to give rise, during the process of healing, to serious disorders of the neighbouring parts. Amaurosis and neuralgia are recorded among the secondary and not unusual consequences of such wounds, when the supraorbitar nerve has become implicated. Under certain conditions of the body, there may be inflammation of the parts within the orbit, extending by contiguity to the membranes of the brain, and proving fatal by leading to the formation of matter within that organ. Amaurosis in the right eye has been known to occur from a contused wound, not of a violent nature, to the right eyebrow. Dr. Wallace of New York, has reported two cases of amaurosis following blows over the infra-orbitar nerve. ('Med. Gaz.' vol. 31, p. 931.) Wounds apparently confined to the external parts of the face frequently conceal deep-seated mischief. A sharp instrument penetrating the eyelid, and passing upwards with any force, will produce fracture of the orbitar plate of the frontal bone, which is known to be extremely thin, and even injure the brain beyond.

Wounds of the orbit.—Sir Astley Cooper relates, that a girl, while playing with a pair of scissors, accidentally fell, and the point of the scissors passed upwards under the upper eyelid. It was found difficult to extract them; the eye became inflamed, but for some days after the accident the child was in the habit of walking a considerable distance daily to receive medical advice. In about ten days she suffered violent pain, with symptoms of inflammation of the brain, under which she died. On inspecting the body, it was found that the orbitar plate of the frontal bone had been fractured, the dura mater torn, and one of the anterior lobes of the brain lacerated. (For a similar case, see 'Med. Gaz.' vol. 41, p. 553.) In several instances in this country, trials for murder or manslaughter have taken place, in which death has been caused by a penetrating wound of the orbit, leading to fracture of the bone and injuring the brain. In the year 1735, the celebrated *Macklin*, the comedian, was tried for having caused the death of Thomas Hallam, by thrusting a stick into his eye. On inspecting the body of the deceased, it was ascertained that the stick had entered the brain through the orbit; the prisoner was found guilty of manslaughter. A somewhat similar case occurred at Liverpool, in February 1843, where a boy killed another by wounding him with a gimlet in the eye. The brain was perforated, and he died in two days. It is necessary for a witness to bear in mind that, owing to the thinness of the orbitar plate, an injury of this kind may be produced by the application, comparatively speaking, of only a moderate force. The following instance, reported by Mr. Watson, will show that a simple cause may produce a serious wound of the orbit. A boy, aged ten, had the birch end of a common broom thrust several times into his face by one of his companions. He became stunned, and was carried home in a state of stupor. He afterwards complained of violent pain in the eye-ball and forehead. Symptoms of inflammation and fever supervened, followed by coma, convulsions and insensibility. He died in about sixteen days after the accident. On dissection, the orbitar plate was found perforated, and pus and lymph were effused at the base of the brain. The left ventricle contained three ounces of pus; it communicated with a wound in the orbit. A small portion of bone was partially separated from the orbitar plate, and projected upwards. For many similar cases, and one in which death took place in six hours, from a wound made by a tobacco-pipe, see 'Hoffbauer über die Kopfverletzungen,' 1842, p. 49. In infants and children, the partition between the orbit and the brain is almost membranous, and it may therefore be perforated by the slightest causes. A man was tried in Scotland, in 1827, for killing a girl, by shooting her. The prisoner had inadvertently discharged a gun towards the high road, where the deceased was standing; she received the shot in her face, but the wounds appeared quite superficial. She died in three days, and it was found that one

small pellet had penetrated the orbitar plate and perforated the brain. It would appear, from a case reported by Dr. Scott, that the orbitar plate need not always be perforated, in order that fatal inflammation of the brain should be set up. A deeply penetrating wound of the orbit only, has caused death under the usual symptoms of cerebral disturbance. ('Ed. M. and S. J.' vol. 43, p. 263.) For a remarkable case of wound of the brain through the orbit, reported by Dr. Neumann, see Casper's 'Wochenschrift,' May 1845.

Wounds of the nose.—These wounds are, generally speaking, of a simple nature, rarely giving rise to serious symptoms; but they are almost always attended with great deformity. If the injury is contused and, at the same time, extensive, a loss of the sense of smelling will probably result. A penetrating wound of the nose, produced by passing a sharp-pointed instrument up the nostril, may destroy life by perforating the cribriform plate of the ethmoid bone, and injuring the brain. Such a wound, it is obvious, might be produced without leaving any external marks of injury. The late Dr. Corkindale, of Glasgow, met with a case in which a man died in nine weeks from the effects of a wound of the nose, whereby the nasal bones were fractured. On inspection, there was a copious inflammatory effusion at the surface of the brain, particularly at the part corresponding to the seat of the violence. An injury to the bones of the nose may prove fatal by giving rise to an attack of tetanus. A case of this kind has been elsewhere related (*ante*, p. 579).

Deformity as a consequence of wounds of the face.—Wounds of the face, when at all extensive, are always followed, in healing, by greater or less *deformity*. A medical witness may, perhaps, find these questions put to him in relation to them: Is the wound likely to be attended with deformity? Could such a wound of the face heal without deformity?—or, Could the deformity, if it exist, have been produced by any other cause than the wound? These questions are of some importance. A person may allege that he was severely wounded in the face, when the medical witness, on examination, may find no trace of such a wound as that described. Again, a person may seek damages from another in a civil action, by alleging that a particular deformity was produced by a wound, when the medical witness may be able to trace its origin to disease, or to some accidental cause.

INJURIES TO THE SPINE.

Injuries to the spine and spinal marrow seldom require medico-legal investigation; but this organ is liable to *concussion* from blows, to compression from fracture of the vertebræ or the effusion of blood, with all the secondary consequences attending such accidents. Concussion of the spinal marrow commonly produces paralysis, affecting the bladder, rectum, or lower extremities. These symptoms may not appear at once, but come on after some hours or days. (*Bowling* v. *S. E. Railway*, Exchequer, Feb. 1859; also *Williamson* v. *London and Brighton Railway Co.*, Guildford Summer Assizes, 1862.) After death no traces of mechanical injury may be discovered. Blows on the spine, unattended with fracture or dislocation, may, according to the observation of Sir B. Brodie, be followed by inflammation and softening of the spinal marrow. A slight injury has been known to cause death, by giving rise to inflammation of the spinal marrow. (See Henke's 'Zeitschrift der S. A.' 1840, 2, 407.) This organ is also liable to compression from slight causes, as will be evident from the following medico-legal case reported by Dr. King, of Glasgow:—A man was tried on a charge of manslaughter. It appeared in evidence that he had thrown the deceased on the ground, and while he was attempting to rise, he caught him by the throat, forced him backwards, and brought his head violently in contact with the ground. Deceased died after a few convulsive gasps. On inspection, the spinal cord was found to be compressed between the body

of the fourth and the arch of the third vertebra, but on removing it, no indentation or laceration of its substance was perceptible. Death had ensued from paralysis of the phrenic nerves. It is remarkable that so slight a degree of violence should have caused so serious an injury, for the affair took place before eye-witnesses. This case shows the necessity of inspecting the vertebral column, when death is alleged to have been caused by violence, and no traces of it are perceptible in other parts of the body. Indeed, it is not improbable that in most cases of sudden death from alleged or suspected violence, where the cause is obscure, if the spinal marrow were examined, the fatal result might be explained by the discovery of some mechanical injury or morbid change in this organ. This part of a medico-legal inspection is, however, commonly neglected. (See 'Ann. d'Hyg.' 1871, 1, 138, and 2, 116.)

Fractures of the vertebræ.—These fractures are generally attended by displacement, and thus produce compression of the spinal marrow. They are the more rapidly fatal in proportion as the injury is high up in the vertebral column. The whole of the body becomes paralyzed below the seat of injury, by the compression of the spinal marrow. If the seat of compression is above the fourth cervical vertebra death is commonly immediate: asphyxia results from paralysis of the nerves which supply the diaphragm, and which are necessary to respiration. In falls on the summit of the head from a height, it sometimes happens, not only that the skull is extensively fractured, but that the dentiform process of the second vertebra is broken off, owing to the head being doubled under the body. This injury to the second vertebra may be the cause of death. From a case related by Mr. Phillips, it would appear that this accident is not always attended with fatal compression of the spinal marrow. ('Ed. M. & S. J.' Jan. 1838.) In one instance the person survived fifteen months (ib. Oct. 1845, p. 527); and in another, in which the fracture was caused by the patient turning in bed while his head was pressed on the pillow, death did not take place for *sixteen* months. (Copland, 'Dict. Pr. Med.,' Paralysis.) On several criminal trials, this injury was proved to have been the cause of death: and in a case tried at Glasgow (*The King* v. *Reid*, D. 71), it became a material question, how far such a fracture might result from disease. It may happen that caries of the bone, or disease of the transverse ligament, will cause a separation of the dentiform process from the second cervical vertebra. The state of the bone in these alleged fatal accidents should therefore be closely examined. In Reid's case an acquittal took place, partly because the deceased had laboured under disease of the spine, and the exact state of the parts had not been noticed. Disease of the ligaments may also lead to a separation, followed by slow or rapid death, according to the degree of pressure. A slight cause may sometimes produce severe and fatal injury to the neck. A lunatic in a private asylum suddenly threw her head back, in order to avoid taking some food that was offered to her; and she died evidently from the compression produced by the displacement of the dentiform process of the second vertebra. A woman died suddenly a month after her confinement: she had been suckling her child at one o'clock in the morning, and at four she was found dead. The viscera of the abdomen, chest, and head were carefully examined, without the discovery of any morbid appearance to account for her death—when, as the brain was being returned into the skull, one of the inspectors noticed a projection at the foramen magnum. On further examination, the dentiform process of the second vertebra was found to have been displaced, and this had so injured the spinal marrow as to destroy life. ('Med. Gaz.' vol. 3, p. 582.) It is not stated whether the bone was in a healthy or diseased condition. The following case shows that the rapidity of death will depend on the degree of compression:—A girl had a stiff neck, as it was supposed, from cold: her head was continually twisted to the left side, but she possessed the power of moving it in the opposite direc-

tion. While in this state, a man suddenly seized her and gave her head a violent twist; she felt immediately severe pain, lost the power of turning her head to the right, and had difficulty of swallowing. These symptoms continued to increase for a month, and she ultimately died from a paralytic affection. On inspection, the ligaments of the first and second vertebræ were found ruptured, but there was no mark of suppuration. The bones were healthy. The dentiform process had compressed the anterior columns of the spinal marrow, which were softened; it was observed during life that she had lost more of the power of motion than of sensation. ('Gaz. Médicale,' Nov. 1842.) A displacement of the dentiform process may take place from very slight causes. In a case which occurred to Petit, a child was instantaneously killed in consequence of its having been lifted up by the head. There was no doubt that, by the weight of the body and perhaps a sudden jerk, the ligaments which confined the second vertebra to the first had become lacerated, and had produced fatal compression of the spinal marrow. (For another case see Cormack's 'Edinburgh Journal,' April 1845, p. 314.) A man while holding his head in a butting position during a struggle with a friend died suddenly. The friend had forcibly rotated or twisted the deceased's head a few times from side to side by the brim of his hat. On inspection, it was found that the first four cervical vertebræ were fractured—the ligaments were bruised and torn, and blood was effused on the coverings of the spinal cord. This fully accounted for death. ('Med. Times and Gaz.' May 17, 1856.) It is not stated whether there was any disease of the bones. Compression of the spinal marrow sometimes arises, though rarely, from *effusion* of blood from a fall. It is important to remember, that an effusion of blood may also take place from spontaneous causes. In one case, which proved fatal from an accidental fall, a coagulum of blood was found effused into the substance of the spinal marrow, exactly opposite a fracture of the body of the sixth cervical vertebra.

Injuries to the spine and its contents are generally the result of falls or blows, either on the head or the lower part of the column. The secondary consequences of these injuries are sometimes so insidious as to disarm suspicion, and death may take place quite unexpectedly some weeks after the accident. Spicula of bone, separated by fractures, may remain adherent for some time; and, by a sudden turn of the head, be forced off, and destroy life by penetrating the spinal marrow, at a long period after the infliction of the injury. This has been known to happen in fractures involving the margin of the foramen magnum, and in such cases death is immediate.

The spinal marrow has been in some instances wounded in its upper part by sharp-pointed instruments introduced between the vertebræ. Death is an instantaneous result when the wound is above the third cervical vertebra:—there is no part of the spine where a weapon can so easily penetrate as this, especially if the neck be slightly bent forward. The external wound thus made may be very small, and if produced with any obliquity by drawing aside the integuments, it might be easily overlooked, or it might be set down as superficial. For a medico-legal account of a case in which death occurred from a stab in the back of the neck, causing a division of the spinal marrow, see Henke, 'Zeitschrift der S. A.' 1836, H. 2.; and for another case of homicidal injury to the spine, reported by Dr. Eade, see 'Lancet,' May 1855, p. 520.

In fractures of the vertebræ, a person is generally so disabled, whatever may be the situation of the fracture, that he cannot walk or exert himself. We must be prepared, however, for exceptions to this common surgical view of such injuries. On the 27th February 1861, a man, æt. 35, was admitted into the Northampton Infirmary suffering from paralysis of the legs and great pain in the back and in the abdomen. He could give no intelligible account of the cause of his illness. He soon died; and on a post-mortem examination, the

tenth dorsal vertebra was found broken in its body and arch. There was slight displacement, but it was not such as to press upon the spinal cord. A large clot of blood was situated on the sheath of the cord; this had caused the paralysis. It was proved at the inquest that deceased met with a heavy fall on the 15th of February, but that he had walked some distance afterwards, visited several public-houses, went home intoxicated, and lay down to sleep in a yard. He awoke in the morning sober, but was unable to move his legs. In addition to paralysis, the man when admitted was labouring under peritonitis. There was no evidence that he had sustained any injury subsequently to the fall twelve days before his admission; hence there was reason to believe that, in spite of the fractured vertebra, he had not been rendered incapable of motion. There is no doubt that the effusion of blood was the cause of the paralysis, and this did not occur until some time after the fracture, as the result of slow oozing. (See for a case somewhat similar, *Reg.* v. *Slater* and *Vivian*, C. C. C., Sept. 1860. INSANITY.)

CHAPTER 47.

WOUNDS OF THE CHEST—OF THE LUNGS—RUPTURES FROM ACCIDENT—WOUNDS AND RUPTURES OF THE HEART—WOUNDS OF THE AORTA AND VENÆ CAVÆ—WOUNDS AND RUPTURES OF THE DIAPHRAGM—DIRECTION OF WOUNDS OF THE CHEST—WOUNDS OF THE ABDOMEN—DEATH FROM BLOWS ON THE CAVITY—RUPTURES OF THE LIVER GALL-BLADDER SPLEEN KIDNEYS INTESTINES STOMACH AND URINARY BLADDER—MEDICO-LEGAL QUESTIONS CONNECTED WITH RUPTURED BLADDER—WOUNDS OF THE GENITAL ORGANS—MUTILATION.

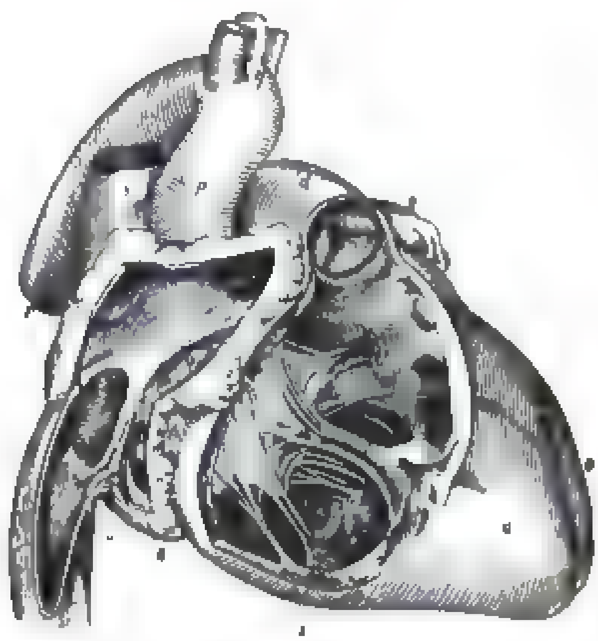
Wounds of the chest.—Wounds of the chest have been divided into those which are confined to the parietes or walls and those which penetrate the cavity. Incised or punctured wounds of the parietes of the chest are rarely followed by dangerous consequences. The bleeding is not considerable, and is generally arrested without much difficulty. They heal either by adhesion or suppuration, and unless their effects are aggravated by incidental circumstances, the person recovers. Contusions or contused wounds of the chest are, however, far more dangerous, and the danger is always in a ratio to the degree of violence used. Such injuries, when severe, are ordinarily accompanied by fractures of the ribs or sternum—by a rupture of the viscera within the cavity, including the diaphragm—by profuse bleeding— or, as an after effect, by inflammation of the lungs, with or without suppuration. Fractures of the ribs are dangerous for several reasons: the bones may be splintered and driven inwards, thereby wounding the lungs and causing hæmorrhage or leading to inflammation of the pleura or lungs. In fractures of the upper ribs the prognosis is less favourable than in those of the lower, because commonly a much greater degree of violence is required to produce the fracture. A simple fracture of the sternum or chest-bone without displacement of the bone, is rarely attended with danger, unless the concussion has at the same time produced mischief internally, which will be known by the symptoms. When, however, the bone is depressed as well as fractured, the viscera behind may be mortally injured. In a case of depressed fracture of the sternum, recorded by M. Sanson, the person died after the lapse of thirteen days; and on inspection, it was found that the fractured portion of bone had produced a transverse wound of the heart about an inch in length. The cavities of the organ had not been penetrated, but the piece of bone was exactly adapted to the depression pro-

duced by it on the parietes. (Devergie, 'Méd. Lég.' vol. 2, p. 243.) A witness will frequently be required to take into consideration the effects of contusions on the chest, with or without fracture, in cases of death from pugilistic combats, which formerly gave rise to numerous trials on charges of manslaughter. Wounds penetrating into the cavity of the chest are generally dangerous, even when slight, in consequence of the numerous accidents with which they are liable to be complicated. In these wounds, the lungs are most commonly injured; but, according to the direction of the weapon, the heart, or the great vessels connected with it, as well as the œsophagus (gullet) or thoracic duct, may share in the mischief.

Wounds of the lungs.—The immediate cause of danger from wounds of these organs is the consequent hæmorrhage, which is profuse in proportion to the depth of the wound and the size of the vessels wounded. Should the weapon divide any of the trunks of the pulmonary veins, the individual may speedily sink. The degree of hæmorrhage cannot be determined by the quantity of blood which escapes from the wound; for it may flow internally, and collect within the cavity of the pleura, impeding respiration. This is especially to be apprehended when the external orifice of the wound is small and oblique, and one of the intercostal arteries has been touched by the weapon. A wound of the lung is generally known, among other symptoms, by the frothiness and florid colour of the blood which issues from the orifice, as well as by the expectoration of blood. The lungs may sustain serious injury from a blow or fall, and yet there may be no external marks of violence or symptoms indicative of danger for some hours. A young man, while riding, fell from his horse on his left arm. He complained of no pain for five hours, but in twelve hours he was seized with an alarming flow of blood from the mouth. He died in the course of a few days. After death there was no external mark of injury to the chest, but the right lung was ruptured posteriorly throughout its length, and much blood had been effused. ('Lancet,' November 1842.) A case somewhat similar to this is reported by Mr. Jardine, of the Winchester County Hospital. ('Med. Times and Gaz.' Dec. 31, 1853.) A boy, aged fourteen, fell to the ground from a height of about twenty feet. He was admitted an hour after the accident, and he died in about two hours after his admission. On examination of the body twelve hours after death, there was no mark of external injury. The collar-bone was fractured, but the ribs had escaped injury. The right lung was found ruptured to the depth of four inches into its substance, and from this a large quantity of blood had escaped, which caused death. This case furnishes another illustration of the production of fatal internal injuries without any corresponding marks of violence externally. (See p. 469.) For another case of laceration of the lung without fracture of the ribs from a carriage passing over the chest, see 'Med. Times and Gaz.' Jan. 19, 1861. During the convalescence of a person who has survived the first effects of a penetrating wound of the chest, the surgeon should observe whether death, when it occurs, may not have been caused either by imprudence on the part of the patient, or by abuse of regimen or other misconduct; for circumstances of this nature may be occasionally treated as mitigatory on the trial of the assailant. It is properly recommended, that in all cases where a person is progressing to recovery, any alteration in the treatment should be made with great circumspection. Too much nourishment, too frequent talking, or any exertion, are circumstances that may cause a renewal of the bleeding and extravasation. A case is related in which a soldier died instantly from internal hæmorrhage, brought on by throwing a bowl at some nine-pins, two months after he had been apparently cured of a wound of the lungs. (Some remarks on penetrating wounds of the lungs will be found in the 'Med. Times and Gaz.' July 24, 1851, p. 98.)

Wounds of the heart.—Wounds of the heart are among the most fatal of penetrating wounds of the chest. It was formerly considered that all wounds of this organ were necessarily and instantly mortal. (See *ante*, p. 609.) Undoubtedly, when either of the cavities is laid open to a large extent, the bleeding is so profuse on the withdrawal of the weapon, that death must be immediate. But when the wound is small, and the weapon penetrates into the cavities of the heart obliquely, life may be prolonged for a considerable period; and cases are on record in which it is probable that such wounds would have healed and the patients have finally recovered, but for the supervention of other diseases which destroyed life. Dupuytren has reported the case of a man who received a stab on the left side of the chest, on November 5th, 1831. He was brought to the Hôtel Dieu, but the symptoms under which he laboured did not lead to the suspicion that he had received a wound of the heart. The man died in eight days, of cerebral disease. On an inspection of his body, it was found that the left ventricle was wounded about the middle and a little to the right, its cavity having been penetrated in a transverse direction. The wound was three lines and a half across, and one line from above downwards. The external fibres of the organ were most separated; the openings diminished gradually, so that the internal fibres were in contact and closed the wound. A boy, in pulling a knife from a companion with the point towards him accidentally stabbed himself in the chest. A small quantity of florid red blood escaped; he vomited, and fell to the ground. He died in eight days. The left ventricle had been perforated and one pound and a half of blood was effused in the chest. This case shows that fatal hæmorrhage is not always immediate. ('Med. Gaz.' vol. 2, p. 721.) In another instance reported by Dupuytren, five or six wounds were made by means of a saddler's needle—most of them penetrating into the left ventricle of the heart. The man died of cerebral disease, twenty-five days after the wounds could have been possibly inflicted; for the needle was taken from him twenty-five days before his death, without any suspicion being entertained of his having wounded himself with it. The cicatrices were visible on an inspection of the body. The quantity of blood found in the chest amounted to about three ounces, and this appeared to have proceeded from the substance of the heart. ('Med. Gaz.' vol. 13, p. 662.) For a case of sudden death as the result of an accidental wound by a fish-bone, see 'Med. Times and Gaz.' May 12, 1860, p. 667; and for cases in illustration of the fact that wounds of the heart are not instantaneously mortal, see 'Med. Gaz.' vol. 2, p. 721.

Fig. 130.



Right side of the heart, with its cavities laid open (Wilson).

1. Cavity of right auricle.
3. Superior vena cava, opening into the upper part of right auricle.
4. Inferior vena cava.
a. Right ventricle.
b. Cavity of right ventricle.
d. Pulmonary artery.
e, *f*. Tricuspid valve.
o. Left ventricle.
p. Ascending aorta.
r. Descending aorta.

It was the opinion of Dupuytren, that these injuries were not necessarily fatal, although I believe, with one exception (*infrà*), there is no case on record in which a person has recovered from a penetrating wound of the cavities of the heart. ('Ed. M. and S. J.' Oct. 1844, 557; also 'Ann. d'Hyg.' 1846, 1, 212.) There are few, probably, who will be inclined to consider them

curable: a remote possibility of simple wounds healing, and of the patient recovering, may be admitted, but until some clear instances of recovery from penetrating wounds of the cavities are reported, the majority of practitioners will continue to look upon them as fatal. From a series of cases collected by MM. Ollivier and Sanson, it appears that out of twenty-nine instances of penetrating wounds of the heart, only two proved fatal within forty-eight hours. In the others death took place at the varied periods of from four to twenty-eight days after the infliction of the wound. (Devergie, 'Méd. Lég.' vol. 2, p. 253.) These differences in the time at which death occurs, as well as the fact that wounds of the heart do not instantly destroy life, have been ascribed to the peculiar disposition of the muscular fibres of the organ, and to the manner in which they are penetrated by a weapon. Thus, as a general principle, it is stated that wounds which are parallel to the axis of the heart are, *cæteris paribus*, less rapidly fatal than those which are transverse to its axis. In a wound which divides the fibres transversely, the opening will be larger, and the hæmorrhage greater, than in one that is parallel to these fibres; and as the heart is composed of different layers, of which the fibres pass in different directions, so, in a penetrating wound of its cavities, while one set tends to separate the edges, another tends to bring them together, and thereby to restrain the flow of blood. It is this action of the fibres which renders wounds of the ventricles less rapidly fatal than those of the auricles, all other circumstances being equal (see case by Mr. Callaway, *ante*, p. 609); but a man has been known to survive a laceration of the left auricle eleven hours. In this case, which occurred to Mr. Hancock, the chest was crushed, and after death it was found that the left auricle was lacerated to the extent of an inch; nevertheless this patient survived the injury for the long period mentioned. ('Lancet,' Jan. 30, 1841, p. 655.) In another instance, where a man was stabbed through the left auricle during a quarrel, death did not take place until after the lapse of seventy-eight hours. ('Med. Gaz.' 40, 520.) In the 17th volume of the 'Medical Gazette,' page 82, a case is reported in which a person is stated to have recovered from a punctured wound of the heart; and Dr. Trugien met with a case in which a man who had been stabbed in the left ventricle survived *five* days. The wound in the heart had partly cicatrized. (See 'Med. Gaz.' vol. 47, p. 42.)

The presence of a weapon in the wound, by mechanically obstructing the effusion of blood, also retards the fatal result. A lunatic, about thirty-four years of age, wounded himself with a very long sharp instrument on the left side of the chest. Two days afterwards he was admitted into the Bicêtre, labouring under oppressed breathing, intermittent pulse, and other serious symptoms. The wounded man stated that he had plunged the instrument into his chest, and had not been able to withdraw it. His symptoms became more aggravated, and he died on the twentieth day after the wound. On inspection, the pericardium and the surrounding parts were found inflamed; and on opening the heart an iron stiletto was discovered to be firmly imbedded in the substance of the left ventricle, which it had entirely traversed, so that its point projected a few lines into the cavity of the right ventricle. The man had obviously died from effusion of blood; but this had taken place slowly, and only after the period of time mentioned had the bleeding sufficed to destroy life. It appears from the observations of M. Ollivier and others, that the right cavities of the heart are more frequently wounded than the left, and of these the right ventricle is most commonly the seat of injury. Out of sixty-four cases of wounds of this organ, twenty-nine were situated in the right ventricle, twelve in the left ventricle, nine in the two ventricles, three in the right auricle, and one in the left auricle. These differences are readily accounted for by the relative situation of the cavities. It appears also, from M.

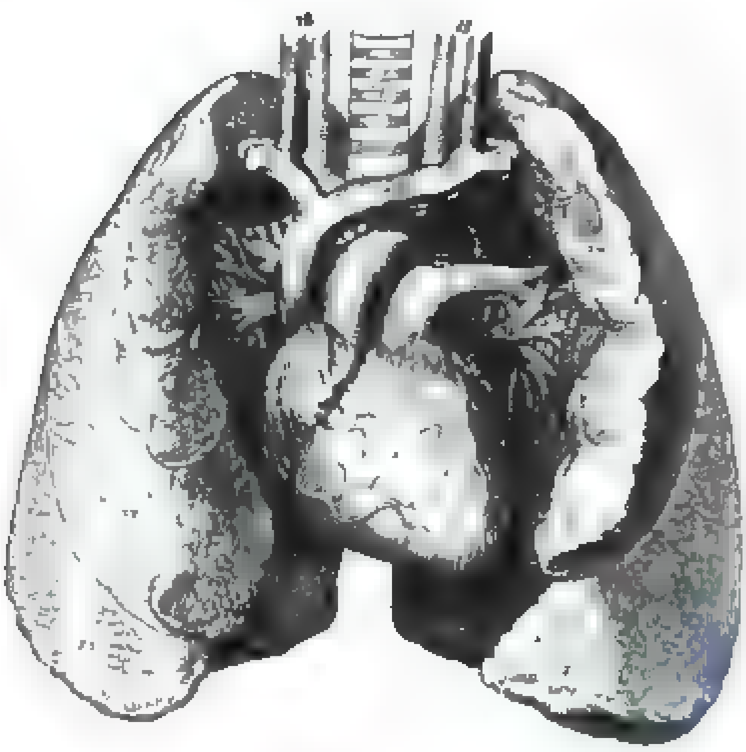
Ollivier's observations, that wounds of the right ventricle are not only the most frequent, but of all others they are the most rapidly mortal. It is considered that the suddenness of death in severe wounds of the cavities of this organ, is to be ascribed not merely to the loss of blood, but to the degree of compression which the heart experiences from that which escapes into the bag of the pericardium. A singular case of accidental wound of the heart, causing death, is reported in the 'Med. Times and Gaz.' for May 12, 1860, p. 467. A woman died suddenly under suspicious circumstances. On inspection, it was found that a large fish-bone had protruded through the stomach and had perforated the heart, causing death by hæmorrhage. In reference to the *direction* of penetrating wounds of the chest, it may be proper to state that the base of the heart corresponds to the upper margin of the third rib on the left side, and the apex to the lower margin of the fifth rib on the same side. (See fig. 97, p. 497.)

Ruptures of the heart.—The heart is liable to be *ruptured* either from disease or accident. In the latter case, the organ generally gives way towards the base, and through one of its cavities on the right side. (For cases, see 'Med.-Chir. Rev.' vol. 31, p. 532.) Dr. Hope asserts that in ruptures from natural causes, it is the left side of the heart, and particularly the left ventricle, in which a rupture is most frequently found. The symptoms are sudden pain, collapse, cramps, cold extremities, and rapid death. According to the circumstances under which they occur, cases of rupture from disease may excite a suspicion of death from violence. Sometimes the substance of the heart appears to have undergone fatty degeneration. Dr. Quain met with a case in which, under this diseased condition, the left ventricle had become ruptured during slight muscular exertion. ('Med. Gaz.' vol. 38, pp. 774 and 857.) Mr. Marshall has reported a case of rupture of the right ventricle under similar circumstances. ('Lancet,' Feb. 16, 1857.) In other instances there has been no apparent alteration of structure. Dr. Stroud reported to the Med.-Chir. Society a case of this kind, which occurred in a young man aged twenty-nine. The deceased died in ten hours after his first seizure; on inspection, there was a small aperture in the right auricle near the vena cava. This did not appear to be connected with any morbid condition of the heart. ('Med. Gaz.' vol. 26, p. 518; 'Lancet,' Nov. 1843.) As a medico-legal subject, it is worthy of note that when this alarming accident proceeds from blows or falls, it is not always accompanied by marks of external violence, or any fracture or other injury to the exterior of the chest. A girl, five years of age, was knocked down and run over by a cart. When brought to the hospital she was quite dead, and there was no mark of injury upon any part of the body. On inspection, the pericardium was found to be full of blood, which had issued from a transverse rent across the apex of the heart. Both ventricles were laid open: the muscular substance was torn to a greater extent than the pericardium. The spine and ribs were unbroken, and there was no injury to any other organ. It was obvious that the injury to the heart had been occasioned by the accident. ('Mem. of Pathological Society,' Jan. 1863.) A case is recorded by Dr. Gairdner, in which a cart-wheel passed over the chest of a child, and occasioned instant death by causing rupture of the heart. Sir R. Christison met with two similar instances, one caused by a fall, the other by a blow. I have been enabled to collect two others, one of which was communicated to me by the late Dr. Geoghegan, of Dublin. A child was killed, as it was supposed by the wheel of a carriage going over its chest. On inspection, the skin, muscles, and ribs were entirely free from any marks of injury. The pericardium was lacerated, and a pint of blood was effused into the right pleural cavity. The heart was found ruptured throughout its entire length. In another case, which occurred to Mr. Jeffery, of Sidmouth, a man fell from

a cliff the height of one hundred feet. There were a few slight bruises about the body, but no serious wound or fracture. On opening the chest, the pericardium was found to be distended with dark fluid blood. which had escaped from an irregular opening about three-quarters of an inch in diameter, situated in the anterior portion of the right auricle. (For another case see 'Cyc. Pr. Med.' vol. 4, p. 557.) In the American edition of this work, a case is mentioned by Dr. Griffiths, in which a boy was run over by a heavy waggon, two wheels of which passed over his chest. He arose apparently not much injured, but on reaching the side of the street, fell dead. On dissection, the heart was found ruptured. The ribs were not fractured, nor was there any laceration of the parieties of the chest.

The *natural* causes of rupture of the heart are violent mental emotions, such as anger, fright, terror, paroxysms of passion, sudden or excessive muscular efforts, or violent physical exertions in constrained positions. The heart, like any other muscle, may also give way from its own powerful contractions. The left auricle of the heart has been ruptured as a mere result of great physical exertion. (See case, 'Med. Gaz.' vol. 47, p. 1063.) Rupture of the heart from any of these natural causes is, however, a rare occurrence. ('Med.-Chir. Rev.' Oct. 1847, p. 460; 'Lancet,' Jan. 23, 1860, p. 88; and Gamgee's 'Pathological Anatomy,' p. 7.) It is of importance for the medical jurist to be aware that rupture of the heart may prove suddenly and rapidly fatal to life, although the lesion may not involve the cavities. Dr. Maclagan met with the following case:—A lady, æt. 75, was suddenly seized with faintness and occasional fits of hurried respiration: she died in about an hour. On inspection, the pericardium was found to be distended with twelve ounces of blood, one-third of which was in a coagulated state. A fissure was found in the superficial fibres about one-third of an inch in length, over the left ventricle and near the septum. There was another and smaller laceration a little higher up. The larger rent communicated with one of the coronary veins, and from this, and some of the smaller arteries in the substance of the heart, the hæmorrhage had proceeded: the lining membrane of the left ventricle was quite sound. Death had been caused by the mechanical effect of the blood in interrupting the heart's action. (Cormack's 'Monthly Journal,' June 1845, p. 421.)

Fig. 131.



Front View of the Viscera of the Chest (Wilson).

1. Right ventricle of the heart. 2. Left ventricle. 3. Right auricle. 4. Left auricle. 5. Pulmonary artery. 6. Right pulmonary artery. 7. Left pulmonary artery. 8. Ligament of the ductus arteriosus. 9. Arch of the aorta. 10. Superior vena cava. 11. Arteria innominata, and in front of it, the right vena innominata. 12. Right subclavian vein, and behind it, its corresponding artery. 13. Right common carotid artery and vein. 14. Left vena innominata. 15. Left carotid artery and vein. 16. Left subclavian vein and artery. 17. Trachea, or windpipe. 18. Right bronchus. 19. Left bronchus. 20. Pulmonary veins; 18, 20, form the root of the right lung; and 7, 19, 20, the root of the left. 21. Superior lobe of the right lung. 22. Middle lobe. 23. Inferior lobe. 24. Superior lobe of the left lung. 25. Inferior lobe.

The heart is here represented without the pericardium, the membranous covering or bag in which it is contained.

When the heart is in a diseased condition, as where it has undergone fatty degeneration, any slight causes of excitement are sufficient to produce rupture and sudden death. The mere exercise of walking may thus give rise to fatal consequences. A case of this kind is reported by Dr. Wharrie, in which a man was found dead upon a high road. The right auricle was found ruptured near the superior vena cava: its substance was thin, soft, and very easily torn. (Cormack's 'Monthly Journal,' May 1846, p. 343.) The same writer describes a singular case, in which a man died suddenly after a struggle with an adversary. No blows had been exchanged. In this instance the walls of the left ventricle were found much thickened, and the aortic valves were ossified: there was no rupture. (Loc. cit.)

Wounds of arteries and veins.—Wounds of the large arterial and venous trunks, around the heart, must be considered as decidedly mortal: death is generally instantaneous from the sudden and profuse bleeding which attends them. Dr. Heil, of Bamberg, has reported a case which proves in his view that a person may recover from a penetrating wound of the *ascending aorta.* (Hencke's 'Zeitschrift,' 1837, b. 2, s. 459.) With regard to these fatal effusions of blood within the chest, as well as in the other great cavities, it may be proper to mention that, from whatever vessel or vessels the blood may have issued, it is not commonly found coagulated to any extent. The greater part of it generally preserves the liquid state: and it is rare that so much as one-half of the quantity effused is met with in the form of coagulum. These effusions of blood in the chest may be sometimes traced to wounds of the intercostal and the internal mammary arteries, or of the vena azygos. Wounds of the *carotid arteries* have been fully considered in the section on wounds of the throat (*ante*, pp. 488, 610). On wounds of the other blood-vessels, whether arteries or veins, it is unnecessary to make any further remark. Death is generally owing to loss of blood, and the bleeding from a comparatively small vessel may prove fatal, according to its situation and the state of the person wounded.

Death from the entrance of air into wounded veins.—In wounds of *veins* there is an occasional and a peculiar cause of death which requires notice, namely, the entrance of air by the open mouth of the divided vessel. Among many cases of this kind I select one which occurred to Dr. Willis, of Barnes: —A man was labouring under chronic laryngitis, and it was considered proper to introduce a seton at the fore part of the neck. The skin was raised, and the seton-needle was passed horizontally through the skin, about two inches and a half above the breast-bone, and not at all near to the jugular vein or any other important blood-vessel. At the instant of its entrance there was a momentary hissing sound—the man became pale—his features were set—he fainted, and he subsequently became rigid and convulsed. The man did not recover his consciousness, was attacked with lockjaw, and died in seven hours. The medical evidence given at the inquest proved that death had not arisen from loss of blood, but from air penetrating through a small vein which had been accidentally divided. A verdict was returned accordingly. After the inquest the body was inspected, and it was then found that the jugular veins and the large vessels of the neck were uninjured. The right auricle and pulmonary artery were distended with frothy blood, and the lungs were emphysematous, distended with much air. ('Med. Gaz.' vol. 41, p. 608.) For another case of sudden death from this cause, see 'Med. Gaz.' vol. 43, p. 1098. See also a paper on this subject in the same journal by Mr. Lane, vol. 45, p. 926. Dr. Bernard has shown that the air thus introduced into veins does not act by paralyzing and obstructing the action of the heart: the obstacle which it creates to the circulation, is in the lungs. ('Leçons,' p. 163.)

It has been long known that air injected into the jugular vein would destroy

life by interfering with the functions of the heart. The exact nature of this accident, as it occurs in operations, is not well understood. (Ferguson's 'Surgery,' p. 444.) According to some, the air rushes into the cavity of the vessel owing to atmospheric pressure during the expansion of the heart, while others believe it to be dependent on the act of inspiration. It is difficult to account for the entrance of air by atmospheric pressure, unless the cut orifice of the vein is kept open, or unless its coats are morbidly thickened, so that it does not readily close when divided; nevertheless, death may thus occur without the slightest imputation on the skill of the operator. Dr. Cormack has shown that in some alleged cases of this kind, death was probably due to loss of blood. When the bleeding is slight, and the hissing sound is heard at the time of the incision, it may fairly be ascribed to the entrance of air. This opinion would be confirmed by the discovery of a frothy state of the blood in the right cavities of the heart. It is worthy of remark, that death may take place from this cause, although a person may recover from the first symptoms. A case has been reported in which a man died under these circumstances in thirteen hours, although he had so far recovered in the interim, that the functions of the lungs and heart were completely restored. ('Association Journal,' Jan. 28, 1853, p. 91.)

Wounds and ruptures of the diaphragm.—The diaphragm, or muscular partition between the chest and abdomen, is liable to be wounded either by weapons which penetrate the cavity of the chest or abdomen, or by the ribs when fractured by violent blows or falls; but, under any circumstances, wounds of this muscle are not likely to occur without implicating the important organs that are in contact with it. It is scarcely possible, therefore, to estimate the danger of these injuries abstractedly, as the medical opinion must materially depend on the concomitant mischief to the adjoining viscera. The annexed engraving, Fig. 132, represents a view of the diaphragm or the muscular partition between the chest and abdomen.

Fig. 132.

Under or abdominal surface of the diaphragm looking upwards—the abdominal viscera being removed (Wilson).

8. Right crus.
9. Lumbar vertebræ.
10. Left crus.
11. Opening for aorta.
12. Opening for œsophagus or gullet.
13. Opening for inferior vena cava.

Slight penetrating wounds of the diaphragm may heal like those of other muscular parts; and cases of this kind are on record. There is, however, especially when the wound is of a lacerated kind, a consecutive source of mischief which no remedial means can avert—namely, that after the wound has, to all appearance, healed, the life of a person may be cut short by the strangulation of a portion of the stomach or bowels in the half-cicatrized aperture. An instance reported by Dr. Smith affords an illustration of this. A sharp-pointed weapon had penetrated the diaphragm, notwithstanding which the patient apparently made a rapid and perfect recovery. At the end of about three months, however, the man died from a strangulated hernia or rupture involving the stomach, which had passed through the wound of the diaphragm into the thorax. ('For. Med.' p. 279.) In a case of this description, when death

occurs at a long period after the infliction of the wound, the witness may probably be required to say—Whether the wound was the cause of death? or whether there were any other circumstances which would have caused or facilitated the production of a hernia. The degree of culpability of an aggressor may materially depend upon the answers returned to these questions. *Phrenic hernia*, as this form of internal rupture is termed, is not by any means an unusual or unexpected fatal consequence of a wound of the diaphragm; and therefore it would appear, at first sight, that death, at whatever period this event may occur, should be referred to the original wound. But the case may present some difficulties, as it is possible that a slight blow on the stomach, received subsequently to the wound, or even any violent exertion on the part of the deceased, might have produced fatal strangulation. A person may survive with a large phrenic hernia for a considerable period, and die from some other cause. A case of this kind has already been related, in which the stomach and part of the intestines were found in the left cavity of the chest, and the person lived for nine months (*ante*, p. 612). The fact of a person surviving will, however, depend on the freedom of communication between the chest and the abdomen. If the aperture is small and unyielding, strangulation may occur, followed by death within the usual period of time. Dr. A. T. Thompson has related an interesting case of this kind. A man fractured two of his ribs by a fall. It was not until twelve months afterwards that he was admitted into University College Hospital, where he died two days after his admission. On inspection, it was found that about fourteen inches of the colon protruded into the chest through an aperture in the diaphragm, so small as only to admit the point of a finger. The intestine had become strangulated, and this had lead to death. There was no doubt that the injury to the diaphragm had been occasioned by the same accident which had caused the fracture of the ribs. The hernia, judging from the symptoms, had taken place only a few days before death. ('Med. Gaz.' vol. 40, p. 584.) Another case has been elsewhere related in which a man, who was stabbed in a quarrel, died from phrenic hernia fifteen months afterwards. These two cases are of importance, inasmuch as they show that death may unexpectedly occur from the effects of an injury to the chest received a long time previously. They also prove the absurdity of that principle of the English law which makes the aggressor responsible for a fatal result only when the death happens within a year and a day after the receipt of a wound. If a person is exculpated when death takes place after fifteen months, in spite of the clearest evidence that violence was the moving cause, then there is no reason why persons should not be equally discharged from responsibility when the wounded person survives ten, five, or even two months. The reader will find some important remarks on phrenic hernia and its fatality in Dr. Reid's 'Physiological Researches,' p. 521.

The most serious injuries to the diaphragm are unquestionably those which are produced by violent contusions or falls on the abdomen, at a time when the stomach and intestines are distended. On these occasions the muscular fibres may be ruptured to a greater or less extent; but the bleeding is not considerable, rarely exceeding two, three, or four ounces. A uniform result of such *ruptures*, when extensive, is a protrusion of the stomach into the chest, with sometimes a rupture of the coats of this organ and extravasation of its contents. Severe lacerations of the diaphragm are more readily produced during the act of inspiration than during expiration—the fibres of the muscle being then stretched, and receiving, while in this state of tension, the whole of the force. According to Devergie, the rupture most frequently takes place in the central tendinous structure, where it is united with the left muscular portion above the crura. He has remarked that it occurs more commonly on

the left side than on the right. (Op. cit. vol. 2, p. 250.) It has been supposed that death was an immediate consequence of this accident, but this view is not supported by facts. In a case of extensive rupture of the diaphragm related by Devergie, in which the stomach and colon were found in the chest, the person lived nine months after the only accident which could have produced it, and then died from another cause. Besides the stomach, it sometimes happens that the liver, spleen, or intestines pass through the opening, and these organs are then liable to become strangulated: the lungs are at the same time so compressed that respiration is stopped, and asphyxia or suffocation may be an immediate result.

Direction of wounds in the chest.—In judging of the *direction* taken by wounds which traverse the chest from front to back, it is necessary to remember the great difference that exists in the level of the same rib anteriorly and posteri rly. This must be especially attended to when we are called upon to state the direction of a traversing wound from the description of it given by another. The point here referred to had an important bearing in the case of a fatal gunshot wound, which was the subject of a criminal charge some years since. (Henke's 'Zeitschrift,' 1836.) A reference to fig. 97, p. 497, will show that, owing to the great obliquity of the ribs, a straight line touching the upper edge of the sixth rib behind would be on a level with the upper edge of the third rib in front.

A person died from a single pellet of small-shot traversing the chest from before backwards. The pellet entered between the first and second rib anteriorly, and, traversing the lung, caused death by lacerating the sixth intercostal artery, near its origin at the lower edge of the sixth rib, posteriorly. In giving an opinion on the direction of this wound—a fact which happened to be important in regard to the position of the assailant—one medical witness, from not duly considering the sloping of the ribs from behind forwards, described the wound behind as being six inches below the level of that in front. As the small canal through the lungs could not be discovered, he was inclined to think that the two wounds could not be connected, because the gun had been discharged from the shoulder when the party firing was nearly on a level with the deceased. This opinion, however, was soon corrected by a reference to the anatomical relations of the parietes of the thorax. Indeed, it will be found that a straight line carried backwards from between the first and second ribs in front will, in a well-formed skeleton, touch the upper border of the fifth rib posteriorly; therefore this wound was nearly *horizontal*—being only one inch and a quarter lower posteriorly, than anteriorly. In the case of Colonel *Fawcett*, killed in a duel, the bullet entered on the right side of the chest, fracturing the *seventh* rib, and after traversing the posterior part of the lungs, lodged in the *ninth* dorsal vertebra. These parts are in a line with each other, and the wound was horizontal. It must not be forgotten that a wound immediately below the chest bone, will in its fore part involve the viscera of the abdomen—in the back part those of the chest, and in its central part it will traverse the diaphragm.

For the better understanding of medical evidence in reference to wounds of the chest, an engraving is given at p. 640, which represents the relative position of the lungs, heart and blood-vessels. The ribs and diaphragm are removed.

Wounds of the parietes of the abdomen.—*Incised and punctured* wounds, which affect the parietes or coverings of the abdomen, without penetrating the cavity, are not quite of so simple a nature as might at first sight be imagined. The danger is immediate if the epigastric artery is wounded; for a fatal hæmorrhage will, in some instances, take place from a wound of this small vessel. In a case which occurred to Dr. Colles, of Dublin, a carpenter who had a chisel

in his pocket stumbled in walking, and received a wound in the abdomen with the edge of the tool. When brought to the hospital, the man appeared exhausted from loss of blood—the skin was cold and pallid; he gradually became weaker, the pulse imperceptible, and he died a few hours after his admission. On an examination of the body, the epigastric artery was found divided, and the cavity of the peritoneum distended with blood. It is true that in this case the abdomen was penetrated, but the real cause of death was the blood lost from the wounded artery. Mr. Travers mentions, that a man was brought to St. Thomas's Hospital, who had been stabbed in the direction of the epigastric artery on the left side of the abdomen, with a case-knife. He died in eighteen hours, apparently owing to bleeding from this vessel. Among the other sources of danger from these superficial wounds, is inflammation followed by suppuration beneath the tendinous membrane which covers the abdominal muscles. The matter formed is very liable to accumulate within the sheath of the muscles, and this may prove fatal unless proper treatment be adopted. The inflammation will sometimes extend to the peritoneum, and thus rapidly destroy life. As improper medical treatment may, in either of these cases, cause a superficial wound of the abdomen to take a fatal termination, so when a person stands charged with having inflicted such a wound, it will be neccessary for a medical witness to consider how far the consequences of the act of the prisoner have been aggravated by negligence or unskilfulness. But when these wounds take a favourable course and heal, there is an after-effect to be dreaded, namely, a protrusion of the viscera at the cicatrized spot, constituting ventral hernia. When the wound has involved the muscular fibres transversely to their course, the cicatrix which follows is commonly far less capable of resisting the pressure of the viscera within, than other parts of the parietes. A hernia may take place, and this, like other herniæ, if neglected, is liable to become strangulated and lead to the destruction of life. The walls of the abdomen, owing to the protrusion of this cavity, are easily penetrated by pointed instruments, and it requires but a slight force to traverse them completely and wound the intestines. A slight wound may thus prove fatal by leading to peritoneal inflammation. In July 1861, a Mrs. *Cuthrey* died from the effects of a penetrating wound, produced by a table-knife being thrown across a dinner-table at her. The point of the knife penetrated the abdomen for about three-quarters of an inch. The deceased died from peritonitis. There was a slight opening in the small intestines.

Contusions are attended generally with far more serious effects on the cavity of the abdomen than on the chest. This arises from the coverings of the abdomen having less power to resist external shocks. In the first place death may be the immediate result of a blow in the upper and central portions; no particular morbid changes may be apparent on inspection, and the violence may have been so slight as not to have produced any ecchymosed mark on the skin. Death has been ascribed in these cases to a fatal shock transmitted to the system through a violent impression produced on the nerve-centre—called the solar or cœliac plexus. Some remarks have already been made on sudden death from blows on this part of the abdomen (see p. 560). Travers, Alison, Watson, Cooper, and other writers on surgical injuries, have referred to cases of this kind as of not unfrequent occurrence. They are of considerable importance in a medico-legal view, as, in the absence of marks of physical injury in the part struck, a jury might be led to doubt whether the blow could have been the cause of death. In *Rex* v. *Jones* (Warwick Summer Assizes, 1831) —a case of alleged manslaughter—prisoner was charged with having struck deceased several blows on the breast, and one on the pit of the stomach, by which he instantly fell down senseless and expired. On dissection no morbid appearances were found. The prisoner was convicted. ('Watson on Homi-

cide,' p. 75.) In another case, tried at the Central Criminal Court in Aug. 1841 (*The Queen* v. *Sayers*), death was thus caused by violence during a pugilistic combat. A man received a blow in the stomach, and fell dead. As there were no marks of external injury, the surgeon thought the deceased had died of apoplexy! The prisoner was acquitted. A similar case was the subject of a trial at the Norwich Lent Assizes, 1854 (*Reg.* v. *Laws*). The deceased, a powerful man, received during a pugilistic encounter a blow on the abdomen, and he instantly fell backwards, dead. On an examination of the body there were no marks of injury, either externally or internally. The surgeon attributed death to sudden shock; and this no doubt was the true cause. The learned judge left it to the jury to say whether they thought the death of the deceased was caused by a blow; but if they could not say what was the cause of death, or if they should think that death was attributable to excitement and that it was independent of the blow, the prisoner would be entitled to an acquittal. A verdict of Not Guilty was returned. Although the blow was seen to be struck, and was a sufficient cause of death under the circumstances, the jury probably thought that there should be some *visible* injury to the body; and, in the absence of this, declined to refer death to the violence. Had the jury possessed any medical experience or knowledge of the causes of death from violence, they would have seen their way through this apparent difficulty. Some surgeons have thought that these cases have not been accurately observed, and that in those which terminate fatally a more careful inspection would probably have shown visible changes in the organic structures. The fact, however, remains: persons have died soon after receiving severe blows on the upper part of the abdomen, and medical men of experience who have examined the bodies for the express purpose of detecting physical injuries, have not found any to record. Moreover they have not found in any part of the body a natural cause of sudden death.

Blows on the abdomen, when they do not destroy life by shock, may cause death by inducing peritoneal inflammation. Several cases of this kind are mentioned by Mr. Watson ('On Homicide,' p. 186), and more than one has been tried of late years where violence to the abdomen was proved, but no mechanical lesion had been produced: the wounded person, however, died from peritonitis in the course of a few days. (*The Queen* v. *Martin*, Cent. Crim. Court, 1839; also *The Queen* v. *Smith*, Manchester Lent Assizes, 1871.) For two other medico-legal cases by Dr. Wharrie, in which death arose from this cause, see Cormack's 'Monthly Journal,' May 1846, p. 340. Peritonitis thus induced, is apt to be accompanied by inflammation of serous membranes in other cavities: thus, it is said, a person may be cut off by pleurisy depending on an attack of peritonitis produced by violence, while the former disease would probably be referred to some other cause. In a case which occurred a few years since, a woman received some severe blows on the abdomen from her husband. She died in five days. There were marks of pleurisy and peritonitis on dissection, the former much more decided. The medical witness, while he allowed that the peritonitis might have been caused by blows, thought that death had been produced by an attack of pleurisy from cold. The jury acquitted the husband. The reporter of the case considers that the attack of pleurisy was immediately dependent on the peritoneal inflammation produced by the violence. (See 'Med. Gaz.' vol. 25, p. 13.) This doctrine requires confirmation, before it can be safely applied to medico-legal practice. Such a sympathetic connexion between the two diseases must not only be rendered probable, but actually proved. Peritonitis thus produced by violence to the abdomen, is not always fatal. ('Lancet,' Jan. 24, 1846, p. 104; also 'Med. Gaz.' vol. 37, p. 460.) Among other instructive cases of this kind, is one recorded by Dr. Allen, in which fatal peritonitis followed a slight amount of

violence. (See 'Lancet,' Jan. 5, 1850, p. 29.) I was present at a trial at the Swansea Lent Assizes, 1863, in which a man was convicted of manslaughter, by giving to the deceased a kick in the lower part of the abdomen. No organ was ruptured, but peritonitis was set up, and death took place in two or three days. Mr. Neill met with the following case:—A soldier, during an action, was struck by a spent ball on the abdomen, over the region of the bladder. The ball fell on the ground at his feet, without either injuring his clothes or even marking his skin. He did not feel much pain at the time, and walked to the hospital, a distance of two miles, with the ball in his pocket, but he died shortly afterwards from peritonitis and inflammation of the bladder. The entire surface of the abdomen presented the appearance of a severe bruise in a few hours after he was struck. (Ed. 'Med. Jour.' March 1863, p. 793.) Violence applied to the abdomen is not, however, always indicated by ecchymosis or injury to the skin. Effusions of blood in the sheaths or tendinous coverings of the muscles, may or may not be indicative of violence. One fact must here be borne in mind, to prevent mistakes in examining a body after death, namely, that blood may be found copiously effused in and round the abdominal muscles, quite irrespective of the application of violence. Dr. John Reid states that he has met with four cases of this description in about five hundred inspections made at the Royal Infirmary. A man, æt. 39, died of disease of the kidneys four weeks after his admission to the hospital. On inspection, a considerable quantity of dark coagulated blood was found effused in the (*recti*) muscles of the abdomen around the navel, without any external appearance to indicate its presence. A man, æt. 40, died of fever three days after his admission. On inspection, twenty-four hours after death, a large quantity of dark-coloured coagulated blood was found in the muscles round the navel. The skin had its natural appearance. In two other cases the effusions were in and around the muscles of the chest. ('Physiological Researches,' p. 511.)

The absence of ecchymosis and abrasion of the skin, is sufficient to show that such extensive effusions are not caused by violence. Blows adequate to produce a laceration of the vessels and hæmorrhage would most probably be attended with ecchymosis, or some visible injury to the skin. At any rate, when such marks of violence are not visible, and there is no evidence of a blow having been struck, a witness would act wisely in declining to attribute the mere effusion of blood to the act of another person. Deeply penetrating wounds of the abdomen are generally fatal by reason of the injury done to the intestines and other organs. In a remarkable case recorded by Mr. Todd, a soldier by accident so fell upon his bayonet that, although the weapon traversed the whole cavity of the abdomen (entering at the back and coming out in front below the navel), the man recovered in about six weeks. ('Med. Times and Gaz.' March 30, 1861, p. 329.) This case is of importance in reference to the situation and direction of wounds (p. 494). Had there been no knowledge of the facts, this accidental wound might have been pronounced homicidal.

Ruptures of the liver.—Blows on the abdomen may prove fatal by causing a rupture of the liver or other viscera, with extravasation of blood; and as it has been elsewhere stated, these serious injuries may occur without being attended with any marks of external violence. Of all the internal organs, the liver and spleen are the most exposed to rupture, owing to their compact structure, which prevents them from yielding to a sudden shock, like the stomach and intestines. Ruptures of the liver may occur from falls or blows; but this organ may be ruptured merely by a sudden action of the abdominal muscles. An accident of this kind happened to a person who was endeavouring to avoid a fall from his horse. ('Male's Jur. Med.' p. 119.) A fall on the feet from an elevated spot may also produce laceration of this organ. ('Ann. d'Hyg.' 1846, 1, 133.) Ruptures of the liver are generally seen on the

convex surface and anterior margin, seldom extending through the whole substance of the organ, but consisting of fissures, varying from one to two inches in depth. The right lobe from its size is more commonly affected than the left. Their usual direction is from before backwards, with a slight obliquity; they rarely intersect the liver transversely. The lacerated edges are not much separated, while the surfaces present a granular appearance. But little blood is met with in the laceration; it is commonly found effused in the lower part of the cavity of the peritoneum, or in the hollow of the pelvis, and is only in part coagulated. Ruptures of the liver, unless they run far backwards and involve the vena cava or portal vein, are not in general attended with any considerable effusion of blood; but the bleeding, should this vessel be implicated, is sufficient to cause the instant destruction of life. Under other circumstances, a person may survive some hours, as the blood may escape only slowly, or it may be suddenly effused in fatal quantity after some hours or days, as a result of violent exertion or of fresh violence applied to the abdomen. A man came into Guy's Hospital a few years since, in whom there were no immediate or urgent symptoms. He was sent away, and a few hours afterwards was found dead in a cell at a police-station. On inspection, the liver was lacerated nearly through its diameter, and as much as a basinful of blood was found in the cavity of the abdomen. ('Med. Times and Gaz.' 1864, 2, 527.) This effusion must have taken place after the man had left the hospital. On the other hand death may be a slow result of this injury. In one case, a man is reported to have died from a rupture of the liver, which had occurred from an accident eight days before. ('Med. Chir. Rev.' Jan. 1836, p. 296.)

In June 1841 a drunken man was admitted into Guy's Hospital. There was no mark of violence about him—but he appeared helpless from intoxication. He died in about nine hours, and on inspection two quarts of blood were found effused in the abdomen. This had flowed from a large rupture in the right lobe of the liver. It had probably escaped slowly, for the man was able to move about just before he died. Another case was admitted into Guy's Hospital in 1861. There was an extensive laceration of the liver, but there were no symptoms of this severe injury, and its existence was not even suspected until the man died suddenly on the day after his admission. Other instances are reported by Dr. Wharrie ('Cormack's Journal,' May 1846, p. 341). Dr. Miller, of Launceston, Tasmania, has communicated to me a case of extensive rupture of the liver as well as of the diaphragm, which fell under his notice in January 1862. A man, who had been in good health half an hour before, was found dead upon the high road, and there was reason to believe that he had been run over by his own dray. The abdomen was found full of effused blood, which had proceeded from a large rupture on the under surface of the right lobe of the liver. It was T-shaped, five inches in the transverse, and about two inches in the longitudinal direction. The diaphragm was ruptured on the right side for about four inches from before backwards, and the liver protruded through the aperture into the chest. On opening the head, about two table-spoonfuls of blood were found effused between the membranes; and the substance of the brain was unhealthy. In this case Dr. Miller could find no marks of external violence. There was not the slightest scratch, abrasion, or discoloration of the skin, but the sixth and seventh ribs were broken transversely near their sternal extremities. From the state of the brain it was thought probable that the man had had an apoplectic seizure, and had fallen under the wheel of the dray.

Ruptures of the liver generally prove fatal within forty-eight hours. One case has been related in which the person survived for eight days; and a case occurred to Dr. Wilks in which a patient in Guy's Hospital survived this serious accident ten days. On inspection, it was found that the diaphragm had been

ruptured as well as the liver, and that the two had united, an abscess having been formed between them. The liver had been lacerated on its right side. ('Lancet,' 1864, Dec. 24, p. 716.) Another case, in which the patient survived ten days, is reported by Dr. Hunter, U.S. Death then took place from internal hæmorrhage. On inspection there was a rupture of the right border, involving the entire thickness of the liver. It arose from a fall from a three-storey window. There were no external marks of injury ('Amer. Jour. Med. Sci.' April 1870, p. 415). Another case which occurred to Dr. Hunter proved fatal in twenty-four hours (the same journal for July 1870, p. 145). In a case in which the liver was found adhering to the false ribs, a fatal rupture was caused as a result of violent muscular action. The liver was large and its substance brittle ('Vierteljahrsschrift,' April 1872, p. 324).

Ruptures of this organ may take place from violence applied to the *chest*, and there may be no marks of injury in the region of the liver. (See case, 'Med. Times,' Aug. 30, 1851, p. 234. For other cases, see 'Med. Gaz.' vol. 47, p. 156.) Mr. Partridge presented to the Pathological Society the liver of a boy who had been run over by a cart. He died almost immediately from loss of blood. There was no external bruising. ('Lancet,' Jan. 21, 1860.) In *Reg.* v. *Cuffery* (Liverpool Winter Assizes, 1863), on which I was consulted, a new question presented itself in reference to these ruptures, namely, the time required for the effusion of a large quantity of blood into the abdomen when none of the large vessels are involved in the laceration. A police-constable was charged with having caused the death of a man. The deceased was drunk, had fallen three times, and had been kicked and maltreated by a mob. The prisoner took or dragged him to the station, and in an attempt to escape, he knocked down the deceased and fell on him, his knee striking the abdomen. The deceased appeared to suffer great pain when he was lifted up, but he was able to walk to the station with assistance: when there he soon became insensible, breathed heavily, and died in a quarter of an hour or twenty minutes afterwards. On inspection, the liver was found to be ruptured in three places, but none of the large blood-vessels were involved. Upwards of three pints of blood were effused in the abdomen, and the medical witnesses agreed that death was owing to internal hæmorrhage as a result of the ruptures. The question, however, arose whether the ruptures were caused by the violence of the prisoner about twenty minutes before death, or by any of the falls and ill-treatment which the deceased had previously sustained. It was contended in favour of the prisoner, that so large a quantity of blood could not be effused in so short a period as a quarter of an hour or twenty minutes, when the rupture involved only the substance of the liver and not the large blood-vessels. Hence it was alleged the rupture must have been caused by the previous violence. One medical witness thought it possible that this quantity of blood might have escaped from the smaller vessels within the time mentioned; another thought that it would have taken at least half an hour for such an extensive effusion to be produced. The jury acquitted the prisoner.

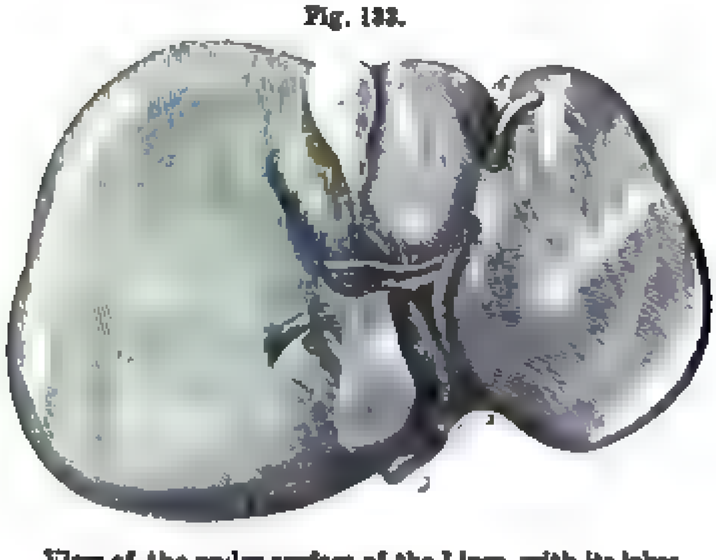
The question here raised was based on too refined a speculation for a satisfactory answer, and it is not surprising that the witnesses differed. The violence received before the prisoner took the deceased into custody, was admitted to have been quite sufficient to account for the ruptures of the liver and the fatal hæmorrhage, and there was nothing to fix it on the act of the prisoner. We have no means of measuring the rapidity with which blood flows on these occasions. A large number of small vessels will pour out as much blood as one or two large vessels. It is stated that the liver was ruptured in three places, hence an extensive bleeding surface must have been exposed. The man was able to walk after the violence, and this exertion may have added to the hæmorrhage. Lastly, the bleeding would probably continue after death, so long as the blood

retained its warmth and fluidity. The prisoner was very properly acquitted, not because the amount of effusion was inconsistent with the time assigned, but because there was a failure of evidence to show that the rupture was caused by his violence. Assuming that the rupture existed when the deceased was struck by the prisoner, it might have been a question whether his violence had not accelerated death by increasing the hæmorrhage.

Wounds of the gall-bladder.—Wounds and ruptures of the gall-bladder are necessarily attended with the effusion of bile. This irritant fluid finds its way into the cavity of the abdomen, and the person dies from peritonitis. A fatal case of this description occurred to Dr. Maclachlan. An old man, while getting out of bed, fell with great violence on the floor. He died from peritonitis in forty-eight hours. The gall-bladder was ruptured, and a large stone was found impacted in the cystic duct. ('Med. Gaz.' vol. 37, p. 968.)

For the better comprehension of medical evidence in reference to ruptures and wounds of the liver and gall-bladder, an engraving is subjoined, Fig. 133, representing the under surface of the liver, with the relative position of the larger blood-vessels. 1. The right or large lobe. 2. The left lobe. 3. The lobus quadratus, so named from its shape. 4. The lobus Spigelii. 5. The lobus caudatus. 6. The longitudinal fissure; the numeral is placed on the rounded cord, the remains of the umbilical vein. 7. The pons hepatis. 8. The fissure of the ductus or canalis venosus. The obliterated cord of the duct is seen passing backwards to be attached to the coats of the inferior vena cava (9). 10. The gall-bladder with its widest part or fundus projecting slightly beyond the anterior margin. 11. The tranverse fissure containing from before backwards the hepatic duct, the hepatic artery, and the portal vein. 12. The vena cava. 13, 14. Depression produced by viscera covered by the liver. 15. The posterior border of the liver; the notch 17 corresponding with the spine. 16. The notch in the anterior border separating the two lobes. It is in this border that ruptures most commonly take place, and in the edge of the right or large lobe.

Fig. 133.



View of the under surface of the Liver, with its lobes and vessels.

Ruptures of the spleen.—Ruptures of the spleen may occur either from violence or disease, and it would appear from the following case, reported by Mr. Heddle ('Med.-Chir. Rev.' Oct. 1839), that a slight degree of violence is sufficient to rupture this organ, while there may be no marks of injury externally. A middle-aged man was observed fighting with a boy about fourteen years of age, who in stature scarcely reached to his waist. When the fight had terminated the boy ran away: the deceased was observed to become weak and faint, and he complained of uneasiness in his left side. He expired a few minutes afterwards. On inspection, no marks of violence could be detected externally; but the cavity of the abdomen contained a large quantity of blood. The spleen was found enlarged, and so softened that its structure was broken down by the slightest pressure. There was a laceration across its surface, about half an inch in depth, from which the fatal bleeding had proceeded. A similar case, in which death occurred in fifteen minutes, is reported in the 'Medical Gazette,' vol. 35, p. 942. The rupture was caused by a blow, but there was

no mark externally to indicate that a blow had been struck. A case of spontaneous rupture of the spleen, which was enlarged and in a diseased condition, is reported in the same journal for June 1842. The late Dr. Easton communicated to me a case (Feb. 1856) in which a little girl died in fourteen hours from rupture of the spleen. The rupture had arisen from the wheel of a cart passing over her body. There was no mark of external violence. It is highly probable that, when the liver and spleen are ruptured from slight causes, the structure of these organs will be found to be in a diseased condition—a circumstance which might in some cases be regarded as mitigatory of the act of an assailant. (See 'Med. Gaz.' vol. 35, p. 942.) A man, æt. 24, was admitted into Guy's Hospital, in November 1864. He had fallen from a masthead, twenty-five feet in height, and it was thought that he had fallen on his back. He was rowed ashore and walked to the hospital, where he arrived about an hour after the accident. He died in a quarter of an hour, apparently from internal hæmorrhage. On inspection, there were no external signs of injury. The abdomen contained several pints of blood. The spleen was torn transversely through its middle, and the splenic vein was lacerated in a longitudinal direction. This organ was about twice its natural size, and soft. It had the appearance of a large ague spleen. ('Lancet,' Dec. 24, 1864, p. 716.) The exertion of walking probably led to the fatal effusion and accelerated death.

Ruptures of the kidneys.—The *kidneys* are occasionally ruptured from violence; but this appears to be a rare accident. Two cases were reported by the late Mr. Stanley to the Med.-Chir. Soc. ('Lancet,' Nov. 1843.) In one, the person recovered; in the other, death did not take place for a considerable time. Another case, which occurred in 1847, has been communicated to me by Dr. Beveridge. The injury occurred during a scuffle—its existence was not suspected during life. A rupture of the kidney may be produced without any prominent symptoms, and cause death in a few hours. A man, æt. 60, who had been run over by a light cart, was brought to Guy's Hospital, in November 1864. He walked to the house of a friend at a short distance, and came with him to the hospital in a cab. It was found that three ribs were fractured, but there was no urgent symptom or sign of collapse. He was treated for fractured ribs, and then walked home with his friend and went to bed. Between five and six hours after the accident he was observed to sit up in bed and suddenly fall back dead. On inspection, Mr. Puzey found no bruise or wound of any kind on the injured side. There was a large quantity of fluid and coagulated blood in the abdomen. This had evidently proceeded from the right kidney, which was torn in half transversely through the pelvis. The ninth, tenth, and eleventh ribs were fractured. It is probable that the blood had escaped slowly from the ruptured organ. The case proves that a kidney may be torn in halves and yet the person possess a power of locomotion and muscular exertion.

Ruptures and wounds of the intestines.—Ruptures of the intestines sometimes occur from disease; and, in a case of rupture alleged to have been produced by violence, we must always take this possible objection into account. The ruptured part of the bowel should be carefully examined, in order to see whether there are any signs of ulceration or softening about it. If not, and there is clear evidence of violence having been used, it is impossible to admit this speculative objection. If with the proof of violence there should also be a diseased condition of the bowel, we may be required to say whether this did not create a greater liability to rupture—a point which must be admitted. (For medico-legal cases of ruptured intestines, see 'Watson on Homicide,' p. 159; Henke's 'Zeitschrift der S. A.' 1836, 'Erg. H.' vol. 22, and 'Brit. and For. Rev.' vol. 4, p. 519.) The intestines may be ruptured by an accidental fall. ('Med. Times and Gaz.' April 13, 1861, p. 403.) Rupture of the intestines

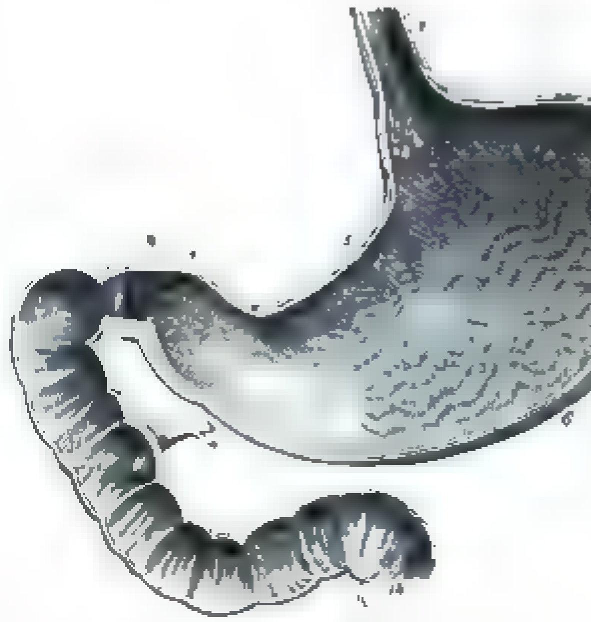
may sometimes occur from very slight causes. Any force, as a smart shock *suddenly* applied to the abdomen, will sometimes suffice to cause it. A case has already been related where the blow of a pebble ruptured the jejunum of a young girl by striking the abdomen. A case is reported by Mr. Newton, in which there was no doubt that the ileum had been ruptured by a kick on the abdomen, leading to death by peritonitis. The coroner and jury appear to have thought that, as there was no mark of contusion or ecchymosis on the abdomen, the blow could not have been the cause of the mischief; hence they came to a verdict that the deceased had died from inflammation of the bowels depending on some unknown causes! ('Lancet,' Aug. 9, 1846, p. 15.) It is worthy of remark, that a rupture of the intestines does not necessarily deprive a person of the power of locomotion. Mr. Collier has reported the case of a boy, æt. 13, whose duodenum was completely ruptured across by a blow: he walked a mile with but little assistance, but he died in thirteen hours. (See 'Med. Gaz.' vol. 12, p. 766.) A boy of 13 was struck by a cricket-ball in the right groin, in spite of which injury he remained on the ground more than an hour and a half, and then walked more than a mile to his home. He died on the fifth day from peritonitis, as a result of rupture of the intestines and escape of the contents. ('Amer. Jour. Med. Sci.' April 1870, p. 485.) A kick in the same part led to rupture of the small intestines, and death in twelve hours. ('Vierteljahrsschrift der ger. Med.' April 1872, p. 235.) That rupture of the intestines is not incompatible with the power of locomotion is also proved by a case related by Mr. Ellis of Dublin, where the cæcum was ruptured: the man was able to walk after the accident, but he died in twenty-four hours. Other instances of this kind are reported by Henke. The ileum is observed to be most liable to rupture from accident. In 1861 a man was brought into Guy's Hospital. He was able to walk to his bed, and he did not appear to be seriously injured, although it was stated that a bale of wool had fallen on him. In the evening he became collapsed, and he died twelve hours after his admission. On inspection, about a pound of blood was effused in the abdomen, and a portion of the ileum was found lacerated—the laceration extending into the mesentery and including the blood-vessels. The laceration was about an inch and a half long, and the bowel was divided not quite through. The intestines were much matted together by lymph and blood, the result of peritoneal inflammation. There had been only slight extravasation of the contents. ('Med. Times and Gaz.' Sept. 1861.) I am indebted to Dr. Croker King for a report of two fatal cases of ruptured jejunum, one arising from a kick on the abdomen and the other from an accidental fall. Dr. King has observed that persons who have sustained this injury retain the power of locomotion and muscular exertion.

Punctured wounds, which merely touch the bowels without laying open the cavity, are liable to cause death by peritonitis. These injuries to the intestines sometimes destroy life by shock; there is but little blood effused, and the wounded person dies before peritonitis can be set up. Severe wounds to the intestines may, however, be inflicted almost without the consciousness of the individual, and the wounded person may be able to walk a considerable distance. ('Med. Gaz.' vol. 46, p. 24.)

Wounds and ruptures of the stomach.—Wounds and ruptures of the stomach may cause death by shock; ruptures commonly give rise to severe pain, which of itself is sufficient to bring about rapid dissolution. It is proper to state, however, that the stomach may be ruptured from spontaneous causes, as in ulceration from disease; but sometimes there is no morbid cause apparent. In April 1828 a man, æt. 34, was brought into St. Bartholomew's Hospital, complaining of severe pain in the abdomen. Ten hours afterwards he was seized

with violent vomiting, the pain ceased, the vomiting also ceased, and he died in five hours more. The posterior surface of the stomach was found lacerated to the extent of three inches, and its contents had escaped through the aperture: the mucous membrane was reddened, but there was no thickening, ulceration, or any apparent disease. ('Med. Gaz.' vol. 2, p. 182; also 'Dub. Med. Jour.' May 1845; and 'Ed. Med. and Surg. Jour.' Oct. 1845, p. 522.) A similar case occurred to Mr. Allen. A boy, æt. 10, had great pain in the abdomen, which was much swollen, and he died in a few hours, in a state of collapse. After death, the cardiac extremity of the stomach, which was softened, but not otherwise diseased, was found ruptured. ('Lancet,' Jan. 3, 1846, 15.) A case, somewhat similar to this in its pathological features, is recorded by Signor Morici. A man, æt. 30, labouring under intermittent fever, died suddenly, after having been to the water-closet. On inspection, the stomach was found ruptured on its anterior surface, to the extent of about two inches, and the contents had escaped into the abdomen. There was no softening or morbid change in the coats, with the exception that the mucous membrane was dotted with redness for a slight distance around the aperture. ('Phil. Med. Examiner,' Nov. 1845, p. 695.) A case, in which the stomach was ruptured at its pyloric end, occurred to Dr. Buist, U.S. The spleen was also ruptured by the same accident—a fall of about twenty feet. The man died in about fourteen hours, evidently from internal hæmorrhage. The rupture was about five inches in length, and extended from the pyloric end of the stomach into the duodenum. ('Amer. Jour. Med. Sci.' Oct. 1870, p. 575.) A remarkable feature of this case was that there was no indication of external injury—no bruises, contusion, or any of the usual effects of violence. Such an injury is not inconsistent with the power of locomotion, although it may be doubted whether in the case reported the large rent in the stomach took place until just before death. ('Brit. Med. Jour.' Dec. 1870.) It is obvious that, in alleged lacerations from violence, this liability to spontaneous rupture must not be forgotten. Penetrating wounds of the stomach generally prove rapidly mortal; they seldom form a subject for medico-legal investigation. A singular case was tried at the Norwich Assizes in 1832, in which a man was charged with the murder of his wife, by throwing at her a red-hot poker. The weapon completely perforated her stomach, and the woman died in six hours. It might be a question whether this was a *wound* in the common sense of the term—it was an injury compounded of a burn, puncture, and laceration.

Fig. 134.



Vertical and longitudinal section of the stomach and duodenum (Wilson).

1. Œsophagus or gullet.
2. Cardiac orifice of the stomach.
3. Cardiac or greater end.
4. Pyloric or lesser end.
5. Lesser curvature.
6. Greater curvature.
8. Rugæ (folds) of the stomach formed by the mucous membrane; their longitudinal direction is shown.
9. Pylorus.
10. Ascending portion of duodenum.
11. Descending portion of duodenum.
12. Ducts of the pancreas and liver.
14. Transverse portion of duodenum.
15. Commencement of jejunum. The transverse striæ or folds in the interior of the duodenum and jejunum represent the valvulæ conniventes.

The illustration, Fig. 135, represents the stomach, and the small and large

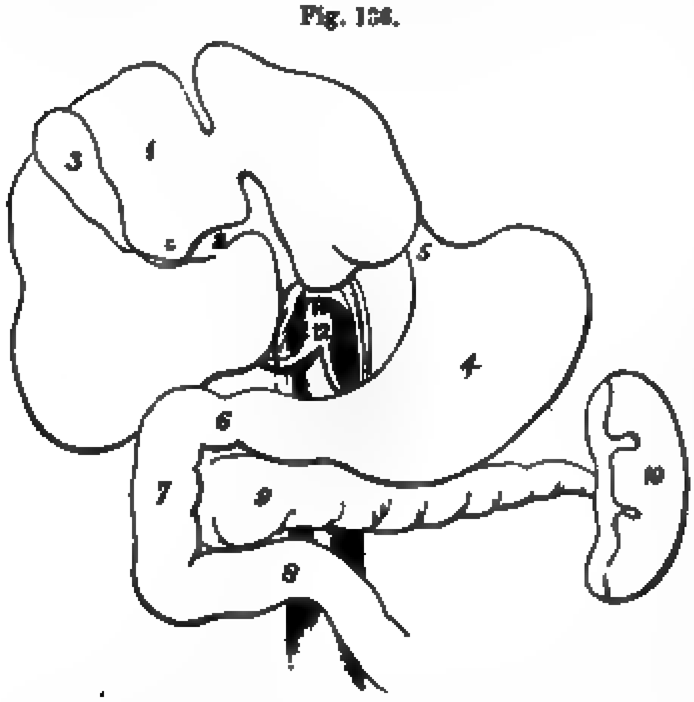
intestines. The stomach is seen in section, with its cavity laid open. *a*. The stomach, with its cavity seen in section. *b*. The œsophagus, or gullet, opening into *c*, the cardiac, or larger end of the stomach (on the left of the body). *d*. The pyloric, intestinal, or right end of the stomach. *e*. The situation of the pylorus, or valve which separates the cavity of the stomach from that of the intestines. *f*. The duodenum, or first portion of the small intestines seen in section. *g*. The convolutions of the jejunum, or second portion of the small intestines. *h*. The convolutions of the ileum, or the third and lowest portion of the small intestines. *i*. The cæcum, or blind-bowel, the first portion of the large intestines. *k*. The appendix vermiformis of the cæcum. *l m n*. The ascending transverse and descending colon, the second portion of the large intestines. *o*. The sigmoid flexure of the descending colon. *p*. The rectum, or straight bowel, the third and last portion of the large intestines.

Fig. 135.

The stomach, in connection with the small and large intestines.

Fig. 136 represents, in outline, the stomach and duodenum, with the liver, spleen, and pancreas. 1. The liver, of which the under surface is here seen, is raised and turned back, so as to expose the other viscera covered by it. It is divided into two unequal parts by a longitudinal fissure—seen in the upper margin—the right or large lobe being on the left of the engraving, and the left or small lobe being on the right. 2. The transverse fissure of the liver. 3. The gall-bladder, of a pyriform shape, of which the neck is towards the centre of the liver and the thickest part or fundus is towards the anterior margin. 4. Represents the stomach. 5. The entrance of the gullet or œsophagus—the cardiac opening; and 6. The situation of the pylorus, or intestinal opening. 7, 8. The duodenum, or first part of the small intestines, in its descending and transverse portions. 9. The pancreas. 10. The spleen. 11 and 12. The aorta.

Fig. 136.



The liver, stomach, and duodenum, in their relative position with the pancreas and spleen.

Ruptures of the bladder.—This injury, which has on several occasions given rise to medico-legal discussion, is frequently the result of blows on the lower part of the abdomen. The principal questions in reference to the accident are:—Was the rupture the result of wilful violence or of an acci-

dental fall?—or, Did it proceed from spontaneous causes, as from over-distension? The spot in which rupture commonly takes place is in the upper and back part, where the bladder is covered by the peritoneum. The aperture is sometimes large, at others small; but the effect is that the urine is effused, and death takes place sooner or later from peritoneal inflammation. It is commonly stated that ruptures, when attended with extravasation of urine into the peritoneal cavity, are uniformly fatal; but if the rupture occurs in the under part of the bladder, or the urine finds its way into the cellular tissue, the medical opinion is not so unfavourable. Mr. Syme has reported a case of recovery under these circumstances. ('Surgical Contributions,' p. 332.) Some accurate observers have even met with cases of recovery where there was every reason to believe that the peritoneum was involved in the rupture. A case of this description was reported by Mr. Arnott to the Medico-Chirurgical Society in 1843 ('Lancet,' Nov. 1843); another occurred to the late Mr. Caldecott of Dorking. The patient, while his bladder was full, struck the lower part of his abdomen against a post. He fell, but was afterwards able to reach his home with some difficulty, at a distance of one hundred yards. He suffered under all the usual symptoms, and in eighteen hours peritonitis appeared. This was subdued, but again supervened, apparently from rupture of the adhesions. In two months, however, the patient had wholly recovered. ('Lancet,' July 25, 1846, p. 112.) Another case of recovery from this injury is reported by Dr. Mason. ('Amer. Jour. Med. Sci.' Oct. 1872, p. 579.)

The usual period at which death occurs from this accident is in from three to seven days; but Mr. Ellis met with a case in which the person did not die until the fifteenth day. The cause of death is obviously peritoneal inflammation; but a person may die suddenly from this injury as a result of shock. Dr. Paterson has communicated a case of this kind to the 'Association Journal.' (Jan. 28th, 1853, p. 88.) A man, while struggling with another, received a severe kick on the lower part of the abdomen. He fell backwards, and died immediately. On inspection, the brain was congested, but otherwise healthy; the heart was free from disease, but much distended with black coagulated blood. The bladder presented, on the left side of the body, a rent of about two inches; but this organ was in other respects healthy, as well as the urethra. There was some bloody effusion in the cellular tissue. The peritoneum and viscera of the abdomen were uninjured. There were no marks of violence on the body.

When these ruptures are produced by blows they are rarely accompanied by the slightest mark of ecchymosis, or of injury to the skin. Thus, then, there may be no means of distinguishing, by external examination, whether a rupture was really due to violence or to spontaneous causes. They who are unacquainted with this fact might be disposed to refer the rupture to disease, on the supposition that violence should be indicated by the usual characters externally; but there are numerous cases on record which show that this view is erroneous. During a quarrel one man struck another a severe blow on the lower part of the abdomen. The latter was carried home, confined to his bed, and died in seven days. On inspection, there were only a few superficial excoriations on the skin of the abdomen. The bladder was found ruptured to the extent of two inches in its upper and back part; it was highly inflamed. Throughout the abdomen there were the marks of general peritoneal inflammation, of which the man had died. There was a sanguineous fluid effused, exhaling a strong ammoniacal odour. The person who inflicted the blow was convicted of culpable homicide. ('Ann. d'Hyg.' 1836, 207.) Some doubt seems to have been thrown on the correctness of the medical opinion, that the rupture had been caused by a blow, because there was no ecchymosis or other mark indicative of a severe blow over the region of the bladder. The wit-

nesses properly answered, that ruptures of the viscera of the abdomen from violence were not necessarily attended with the marks of violence found in injuries to other parts, owing to the yielding and elastic nature of the parietes. One of them mentioned a case that had recently occurred to him, where a soldier had received in the abdomen a kick from a horse, which had ruptured the small intestines, and caused death; but there was not the slightest trace of violence externally.

In another case (*Reg.* v. *Eccles*, Lancaster Lent Assizes, 1836), the prisoner, who was half-intoxicated, met the deceased on the high-road, and without receiving any provocation gave him a violent kick on the lower part of his abdomen. The deceased turned sick; he attempted to pass his urine, but could not; he was conveyed home, and died from peritonitis in five days. On inspection, there was no ecchymosis, or other injury to the skin indicative of external violence, but the bladder was found ruptured, and the contents extravasated. The rupture was attributed to the blow inflicted by the prisoner. In the defence, it was urged, with great plausibility, that as there was no mark of a blow, the rupture might have occurred spontaneously from simple over-distension. The judge, in summing up, observed that if the rupture was thus occasioned, it was extraordinary that it should have happened immediately after a violent blow had been struck on the part. The distension of the organ might, however, have rendered the blow *more dangerous* than it otherwise would have been. The prisoner was convicted.

As an attempt may be made, in cases in which death has resulted from this injury, to refer rupture of this organ to natural causes, it may be observed that this is an unusual occurrence; a rupture is almost always the result of violence directly applied to the part, while the organ is in a *distended* state. A *spontaneous rupture* may, however, occur: 1. When there is paralysis, with a want of power to expel the urine. 2. When the bladder is ulcerated or otherwise diseased. 3. When there is an obstruction in the urethra from stricture or other causes. A fatal case of rupture of the bladder arising from obstruction as a result of disease, occurred to Mr. Field ('Med. Times and Gazette,' Dec. 13, 1856, p. 590). The causes of spontaneous rupture are easily recognizable by ascertaining the previous condition of the deceased, or examining the bladder and urethra after death. If a man were in good health prior to being struck; if he suddenly felt intense pain, could not pass his urine afterwards, and died from an attack of peritonitis in five or six days; if, after death, the bladder was found lacerated, but this organ and the urethra were otherwise in a healthy condition, there can be no doubt that the blow must have been the sole cause of rupture and death. In such a case, to attribute the rupture to spontaneous or natural causes would be equal to denying all kinds of causation. As to the absence of marks of violence externally, this would be a difficulty only to those who had not previously made themselves acquainted with the facts attending this and other accidents affecting the viscera of the abdomen (p. 469). Nevertheless, a medical witness must be prepared to hear the same line of defence continually urged; it is, of course, the object of a counsel to make the best of a case for the prisoner, and his duty consists in seeing him judged according to law, and not condemned contrary to law. With medical facts, opinions, and doctrines he does not concern himself, so long as they do not serve his purpose. A diseased state of the bladder might probably diminish the responsibility of an accused person for the consequences; therefore the state of this organ should be closely looked to on these occasions. From the summing up of the judge in a case mentioned above, it might be inferred, that the fact of the bladder being *distended* at the time of the blow, would be held an extenuating circumstance; but we can hardly suppose that such would be the deliberate opinion of our judges. The fact is, this most serious injury

is never liable to occur from violence, except when the bladder is actually distended, which is occasionally its natural condition! If there were anything unnatural or abnormal in the bladder containing urine, such a rule might, perhaps, apply; but as it is not so, the rule would hold out to persons a ready means of certainly destroying life without subjecting them to the same degree of responsibility as if they had caused death in any other way. If a pregnant woman be killed by a blow on the abdomen, which causes rupture of the uterus, the act cannot be regarded as admitting of mitigation because the uterus is only occasionally in this distended state. Undoubtedly a blow on the distended bladder or uterus, is more dangerous than when these organs are undistended; but this should not be treated as an extenuating circumstance in favour of the aggressor.

Can the bladder be ruptured by an accidental fall, and if so by what kind of fall?—The following case, reported by Mr. Syme, shows that this accident may readily occur. A woman, æt. 26, fell forwards over the edge of a tub, and fainted immediately. On recovering herself, she complained of intense pain in the abdomen, with inability to pass the urine. Peritonitis came on, and she died in a week. On inspection, a small aperture was found in the upper part of the bladder; the peritoneum was extensively inflamed, owing to the urine which had become effused. The ruptured surfaces had become partly glued together. ('Ed. Med. and Surg. Jour.' Oct. 1836.) Rupture of the bladder may take place from an accidental fall, and cause death without necessarily laying open the peritoneal cavity. Two cases of this kind have been reported by Mr. Spencer Wells. ('Med. Gaz.' vol. 36, p. 621.) The patients were sailors who fell from their hammocks while in a state of intoxication. The usual symptoms followed; one died in five, and the other in eight days, from peritonitis; and after death it was clearly found, in one instance at least, that the bladder had been ruptured in the usual situation, but the peritoneum was entire, although in a state of intense inflammation. Another case of this kind, which was the subject of a trial (*Reg.* v. *Dixon*, Durham Lent Assizes, 1846), was communicated to me by Mr. Steavenson. The prisoner kicked the deceased in the pubic region from behind. The man died from peritonitis in thirty-five hours. On inspection, the bladder was found ruptured near its neck for about half an inch, immediately above and to the left of the prostate gland. The urine was extravasated in the cellular tissue of the scrotum: but although there was extensive inflammation, the peritoneum was not lacerated On the other hand, a remarkable case is reported by Mr. Bower, in which a man died on the sixth day from rupture of the bladder; and after death, although the peritoneum was lacerated, and the cavity of the abdomen was filled with dark-coloured urine, there was no sign of peritoneal inflammation ('Lancet,' Dec. 19, 1846, p. 660.) This accident is liable to occur in women during parturition, owing to the pressure of the child's head; an occurrence which may throw a charge of malapraxis on the medical attendant. He is expected to know the probability of such an accident occurring, and to guard against it, if necessary, by the frequent use of the catheter. In *Reg.* v. *Balsoner* (Liverpool Lent Assizes, 1838), a surgeon was tried on a charge of this kind. It is important to remember, that although rupture of the bladder is commonly attended, at the time of its occurrence, with intense pain, sickness, and prostration of strength, yet persons may occasionally retain the power of exerting and moving themselves after the accident. (See page 612.)

In punctured and incised wounds of the bladder, the urine is immediately extravasated, but in gunshot wounds the extravasation does not commonly take place until the sloughs have separated. Thus, life may be protracted longer in cases of gunshot than under other wounds of the bladder. Barzellotti relates the case of a medical student, shot through the bladder in a duel,

who did not die until the *twentieth day* from peritonitis which supervened on the extravasation. ('Questioni di Med. Leg.' t. 3, p. 174.) One instance of a person recovering from a gunshot wound perforating the bladder, is reported by Mr. Douglas in the 'Ed. Med. and Surg. Jour.' vol. 13. For the discovery of effused liquids or blood, in wounds and other injuries to the abdominal viscera, we must look to the cavity of the pelvis, as it is here that, for obvious reasons, such liquids have a tendency to collect.

Wounds of the genital organs.—Wounds of these organs do not often require the attention of a medical jurist; such wounds, whether in the male or female, may, however, prove fatal to life by excessive hæmorrhage. Self-castration or mutilation is not unfrequent among male lunatics and idiots. An inquest was held some time since in London, upon an idiot, who had bled to death from a wound of this description. When timely assistance is rendered, a fatal result may be averted. The practice of circumcision on infants is sometimes followed by fatal results. Dr. Schwartz, of Vienna, met with two cases of boys eight days old, who were submitted to this rite. They both died of phlegmonous inflammation, one five days and the other twenty-five days after the operation. (Lancet, 1870, 2, 471.)

Incised, lacerated, or even contused wounds of the female genitals, may prove fatal by loss of blood, not from the wound involving any large vessel, but from the numerous small vessels which are divided. Two women were in this way murdered in Edinburgh some years since. The wounds were inflicted by razors, and the women bled to death. (See cases by Watson, p. 104.) This crime appears to have been at one time frequent in Scotland. When deeply *incised* wounds are inflicted upon the genital organs of either sex, the fact of their existence in such a situation at once proves wilful and deliberate malice on the part of the assailant. Accident is wholly out of the question, and suicide is improbable, except in cases of confirmed idiocy and lunacy. Such wounds require to be carefully and minutely examined; for the proof of this kind of wound when fatal, may be tantamount to a proof of murder. A contused wound of the genitals may cause death by hæmorrhage. A case is reported in which a woman, in the eighth month of pregnancy, fell from a chair, which also fell with her. There was hæmorrhage, and she died in a quarter of an hour. The blood had flowed from a wound an inch and a-half long, situated between the right labium and the urethra. The edges appeared to be cleanly divided, and the wound penetrated into the cellular tissue. ('Dub. Quart. Jour.' 1870.) There should be no difference of opinion here on the question, whether the wound has arisen from accident or criminal violence. In a case (*Reg.* v. *Ling*) referred to in the 'Lancet,' 1870, 2, 268, the medical evidence for the prosecution went to show that a wound in the vulva of a female found dead from hæmorrhage, had been produced by a stick on which blood and hair were found. A medical gentleman who appeared for the defence thought that a varicose vein had burst and caused the bleeding, and that the injury had not been produced by the violent use of a stick. Under this wide difference of opinion the jury properly acquitted the prisoner, but it is difficult to comprehend how, with a proper examination of the wounded parts, such a difference of opinion on the cause of the hæmorrhage could have arisen.

A practitioner may be sometimes required to determine whether wounds affecting the female organs have resulted from accident, have been self-inflicted, or inflicted by others with homicidal intention. In June 1842, a woman received a wound in the genitals on the left side by a cutting instrument, to the extent of an inch and a-half in a longitudinal direction. There was a smaller wound on the right side. The accused alleged that the woman had inflicted the injury on herself; and the late Dr. Easton of Glasgow, on being required to state his opinion on the question at issue, came to the conclusion: 1. From

the regular edges of the wounds, that they had been produced by a clean cutting instrument, and therefore could not have been caused by a fall, excepting the person had fallen upon some sharply cutting projection. 2. If the woman had injured herself by thrusting a knife into the private parts, the situation and direction of the wounds would have been different. There was a want of proof to connect the prisoner with the act, and he was discharged. This is an improbable situation for the self-infliction of wounds with a view to suicide. Accidental wounds of the genitals, unless all the circumstances are known, may sometimes resemble those produced by design. A girl, æt 6, fell from a tree with her legs apart upon one of the sharp-pointed shoots below, about half an inch thick. This entered the vagina, and passing through its posterior wall, broke off. A woman removed the wood with some difficulty. The child died in twenty-eight hours from peritonitis. ('Lancet,' 1871, 2, 74). Had this child been found dead with the wood in her body, there might have been some difficulty in assigning an accidental origin to such an injury. (For remarks on wounds of the male genital organs, see 'Ann. d'Hyg.' 1868, 2, 110. Toulmouche.) Some rules which have been elsewhere given (p. 472) may enable a witness to form an opinion when a question of this kind is involved in doubt. (For cases in which such wounds were homicidally inflicted upon males, see 'Ann. d'Hyg.' 1848, 1, 443; also 1865, 1, 156; and for a case, which led to a trial for the murder of a woman, see 'Med. Gaz.' vol. 44, p. 813.)

Contused wounds on the female genitals prove sometimes fatal, by the laceration of parts leading to great loss of blood. Several trials for manslaughter have taken place in which this was proved to have been the cause of death. (See the case of *Reg.* v. *Cawley*, Liverpool Winter Assizes, 1847; also a paper by Mr. Barrett, 'Assoc. Med. Journal,' June 28, 1856, p. 538.) There may be such a loss of blood in these cases as to destroy life, although no large blood-vessel is implicated in the injury. A contused wound on the vulva may occasionally present an ambiguous appearance, and be mistaken for an incised wound. When the soft parts of the body are struck by a blow or kick, if there is a bony surface beneath, a longitudinal rent may appear as a result of the force being received by the bone. A blow on the cranium with the fist produced in one instance a rent which was at first mistaken for a cut. A kick on the vulva, or a fall on this part, may produce a similar injury, and, unless carefully examined, may lead to the inference that a weapon has been used for its production. Mr. Barrett, in the paper above referred to, has properly directed attention to this subject. A case in which a contused wound of the clitoris proved fatal has been communicated to the 'Lancet' by Mr. Gutteridge. (Oct. 31, 1846, p. 478.) A woman, æt. 36, received a kick from her husband in the lower part of the abdomen while she was in a stooping posture. She was seen by Mr. Gutteridge in about three-quarters of an hour, and she had then lost from three to four pounds of blood. She was sinking, and expired in a few minutes after his arrival. On inspection there was no injury to the uterus or vagina; the wound was situated at the edge of the vulva, extending from the pubes along the ramus of that bone. It was about an inch long and three-quarters of an inch deep. The left crus clitoridis was crushed throughout its length, so as to exhibit its cavernous structure. From this the fatal bleeding had proceeded. The heart and great vessels contained no blood. The bleeding from such injuries is always likely to be more profuse when the woman is pregnant; but a case of recovery from a contused wound to the genitals in a pregnant woman, æt. 40, is reported by Dr. M'Clintock. It is stated that there was profuse bleeding from a laceration involving the urinary passage, but under early treatment the woman did well. ('Medical Times,' May 15, 1847, p. 233.) It is well known that some women are subject to frequent discharges of blood from the genital organs from natural causes. When the bleeding im-

mediately follows a blow, and the woman has not been subject to such a discharge, the fair presumption is that violence was the cause; but when the flow of blood appears only a long time after the alleged violence, of which no traces can be seen, it is most probably due to natural causes. A case of this kind has been communicated to me by Mr. Procter of York. There was no difficulty in giving an opinion that the flow of blood was *not* due to violence.

It may be alleged in defence that the injuries found on the body were inflicted *after death*, and not while the deceased was living. Kicks or blows on the vulva, if they destroy life at all, cause death by copious effusion of blood. Violence to this part after death would not produce such an effusion as would account for death. There are also other distinguishing characters which have been elsewhere pointed out (see p. 459). A case was tried in Edinburgh, in which this defence was set up; but the late Sir J. Simpson was enabled to say, from his observation of the effects of such violence to a dead body, that the injuries in question could not have been produced after death.

CHAPTER 48.

FRACTURES—PRODUCED BY A BLOW WITH A WEAPON OR BY A FALL—OCCUR IN THE AGED—BRITTLENESS OF THE BONES—FRACTURE CAUSED BY SLIGHT MUSCULAR EXERTION—IN THE LIVING AND DEAD BODY—HAS A BONE EVER BEEN FRACTURED?—LOCOMOTION—DISLOCATIONS FROM VIOLENCE OR NATURAL CAUSES—MEDICAL OPINIONS—ACTIONS FOR MALAPRAXIS.

FRACTURES.

FRACTURES of the bones have some important bearings in relation to medical jurisprudence. They may result from falls, blows, or the spontaneous action of the muscles.

Causes.—Questions are sometimes put as to whether a particular fracture was caused by an accidental fall or a blow; and if by a blow, whether by the use of a weapon or not. It is obvious that the answers must be regulated by the circumstances of each case. In examining a fracture, it is important to determine, if possible, whether a *weapon* has or has not been used, and this may be sometimes ascertained by the state of the parts. It is a common defence, on these occasions, to attribute the fracture to an accidental fall. Fractures more readily occur from equal degrees of force in the old, than in the young, and in the young rather than in the adult; because it is at the adult period of life that the bones possess their maximum degree of firmness and solidity. The bones of aged persons are sometimes very *brittle*, and slight violence will then produce fracture. This has been regarded as an extenuating circumstance, when the fracture produced by a slight blow was followed by death. Certain diseases, such as syphilis, arthritis, cancer, scurvy, and rachitis, render bones more fragile; but they are sometimes preternaturally brittle in apparently healthy persons, and this brittleness appears to be hereditary. ('Dub. Hosp. Gaz.' Feb. 1846, p. 186.) In such cases, a defence might fairly rest upon an abnormal condition of the bones, providing the violence producing the fracture was slight. Several trials have taken place in which this brittleness of the bones became a subject of inquiry. In a case of fractured skull leading to death from inflammation of the brain, it was proved that the bones of the skull were occasionally thin and brittle, and this led to a mitigation of punishment. (*Reg.* v. *Kennedy*, Gloucester Winter Assizes, 1855.) The orbitar plate of the frontal bone is very thin, and it may be fractured by a blow on

the eye. (*Reg.* v. *Wilson*, Oxford Lent Assizes, 1859.) Death was here caused by inflammation of the brain as the result of such a fracture. There is occasionally another condition of the skull, namely, a congenital depression or thinning of the outer table, which may be mistaken for fracture. In *Barnett* v. *Roberts* (Court of Exchequer, Nov. 1867), an action was brought by plaintiff, a surgeon, for injury resulting from an assault by the defendant. It appeared from the evidence that the defendant struck the plaintiff two violent blows on the head with the handle of his umbrella. It was alleged that this had caused a fracture of the skull, and had produced a long and painful illness. Mr. Erichsen and Dr. F. Winslow gave evidence for the plaintiff to the effect that in their judgment the skull was fractured, the brain organically injured, and the plaintiff's recovery rendered practically hopeless. On the other hand, for the defence, Mr. Partridge, Mr. Wood, and other witnesses, deposed that the skull was not fractured—that the depression supposed to indicate the fracture was congenital and not the result of a blow or accident. A skull with a natural depression in it was produced and shown to the jury. The plaintiff's head was examined in court by Mr. Partridge. He could feel no cicatrix in the alleged seat of injury, but there was a thickening over the depression. On this evidence the jury could not agree. There would be no difficulty in such a case if a careful examination was made soon after the assault; but when surgical opinions are taken some weeks or months afterwards, the witnesses are not likely to agree. Even if there had been a cicatrix on this occasion, this would not have proved that the skull had been fractured. The injury to the brain might well have been a result of the violence, although there had been no fracture.

Spontaneous Fractures.—In a case in which there is no appearance of disease, a fracture may be ascribed to spontaneous causes. Thus bones have been fractured by moderate muscular exertion. The elbow (olecranon), heel-bone (os calcis), and knee-pan (patella), are particularly exposed to this accident. The long bones are seldom the subject of an accident of this kind; but the arm (os humeri) in a healthy man has been broken by the simple muscular exertion of throwing a cricket-ball. ('Med. Gaz.' vol. 16, p. 659.) Mr. May reports the case of a young lady, who fractured the neck of the scapula by suddenly throwing a necklace round her neck. ('Med. Gaz.' Oct. 1842.) In July 1858, a gentleman, æt. 40, was in the act of bowling at cricket, when on delivering the ball he and some bystanders heard distinctly a sharp crack like the breaking of a dry piece of wood. He fell to the ground as if he had been shot. The thigh-bone was found to be fractured, and evidently from muscular exertion only. In November 1871, while a strong young member of the Scottish volunteers was in the act of 'putting' a sixteen-pound shot, making at the time a violent effort, he felt something snap in his arm and instantly lost all power over it. It was found on examination that the humerus had been broken by muscular force. No person can meet with an accident of this kind without being instantly conscious of it. It is probable that in these instances, if there were an opportunity of examining the bone, it would be found to have undergone some chemical change in its composition, which had rendered it brittle. A case of spontaneous fracture of the femur was brought into Guy's Hospital, in December 1846. A healthy man, æt. 33, of temperate habits, was in the act of placing one leg over the other to look at the sole of his foot, when he heard something give way, and the right leg immediately hung down. On examination, it was found that the right thigh-bone had been transversely fractured at the junction of its middle with the lower third. This case is remarkable inasmuch as spontaneous fractures of the thigh-bones are very rare, as the man had not suffered from any of those diseases which cause preternatural fragility, and the fracture was not caused by violent muscular exertion.

The actual condition of the bone was of course unknown; but it healed readily, and the man left the hospital at the usual period. In fractures arising from this cause there will be no abrasion of the skin, nor any appearance to indicate that a blow has been struck; while the marks of a blow would, of course, remove all idea of the fracture having had a spontaneous origin. It is most unusual that the ribs should be fractured from muscular exertion; but a case occurred to Dr. Groninger, which shows that this accident may readily occur. It is only of medico-legal importance, inasmuch as the injury might be falsely ascribed to violence; but the absence of any external appearances indicative of a blow would show that this was not the cause. Dr. Groninger's patient was a strong healthy labourer, æt. 45, who, slipping while walking, only saved his footing by the exertion of considerable strength. While recovering his balance he felt a sharp pain on his right side, which was aggravated by inspiration and by exertion, so that he reached home with difficulty. On examination a tender spot of about half a hand's breadth was found in the axillary region over the seventh and eighth ribs. Crepitation was not distinct, and emphysema was not present. As the pain occurred so suddenly, and was limited to so small a space, it was supposed that a rupture of the muscular fibres had taken place, although the absence of all swelling and effusion, as well as of any depression amidst the fibres, rendered this not very probable. Pleurisy was set up, and the patient was confined to bed for a fortnight; when all traces of pain had left the part, the deposition of callus (new bone) plainly showed that there had been fractures of the seventh and eighth ribs. ('Archiv. der Heilkunde,' vol. 1, p. 473; also 'Med. Times and Gaz.' April 1861, p. 450.)

Fractures are not *dangerous to life*, unless, when of a compound nature, they occur in old persons, or in those who are debilitated by disease or dissipated habits. They may then cause death by inducing irritative fever, erysipelas, gangrene, tetanus, pyæmia, or delirium tremens.

Fractures in the living and dead body.—It is not always easy to say whether a fracture has been produced *before or after death*. A fracture produced shortly after death, while the body is warm, and another produced shortly before death, will present similar characters, except that in the former case there might be less blood effused. A fracture caused ten or twelve hours before death would be indicated by a copious effusion of blood into the surrounding parts and between the fractured edges of the bones, as well as by laceration of the muscles; or if for a longer period before death, there may be the marks of inflammation. Fractures caused several hours after death are not accompanied by an effusion of blood. A medical witness may be asked, How long did the deceased survive after receiving the fracture? This is a question which can be decided only by an examination of the fractured part. Unless the person has survived eighteen or twenty-four hours, there are commonly no appreciable changes. After this time, lymph is poured out from the surrounding structures. This slowly becomes hard from the deposition of phosphate of lime, and forms what is called a 'callus' (new bone). In the process of time, the callus acquires all the hardness of the original bone. The death of a person may take place during these changes, and a medical man may then have to state the period at which the fracture probably happened, in order to connect the violence with the act of a particular person. Unfortunately, we have no satisfactory data, if we except the extreme stages of this process of repair, upon which to ground an opinion. We can say whether a person lived for a long or a short time after receiving a fracture, but to specify the exact time is clearly impossible; since this process of restoration in bone varies according to age, constitution, and many other circumstances. In young persons, bones unite rapidly, in the old slowly; in the diseased and unhealthy the process of union is slow, and sometimes does not take place at all. In those who are at the time affected

with a mortal disease there is usually no attempt at reparation. (Sir A. Cooper.) According to Villermé, the callus assumes a cartilaginous structure in from sixteen to twenty-five days; and it becomes ossified in a period varying from three weeks to three months. It requires, however, a period of from six to eight months for the callus to acquire all the hardness, firmness, and power of resisting shocks possessed by the original bone. A force applied to a recently united bone will break it through the callus or bond of union, while after the period stated the bone will break as readily through any other part. It is generally assumed that the period required for the union of a simple fracture in a healthy person, is, for the thigh-bone, six weeks; for the tibia (leg), five weeks; for the os humeri (arm), four weeks; and for the ulna and radius (forearm), three weeks; for the ribs, about the same period: but cases have been known in which the ribs had not perfectly united in two months, and in some fractures of the other bones it was found that union had not taken place in four months. In a case which occurred to Dr. Reid (*ante*, p. 627), a fracture of the tibia, the principal bone of the leg, had healed in three weeks.

Has a bone ever been fractured?—This question is sometimes put in reference to the *living* body. It is well known that a bone seldom unites so evenly that the point of ossific union is not indicated by a node or projection. Some bones are so exposed as to be well placed for this examination, as the radius, the clavicle, and tibia,—these being but little covered with skin; in others the detection is difficult. It is impossible for us to say when the fracture took place; it may have been for six months or six years—as, after the former period, the bone undergoes no perceptible change. These facts are of importance in relation to the *dead* as well as to the living; since they will enable us to answer questions respecting the identity of skeletons found under suspicious circumstances: and here medical evidence may take a wider range, for a fracture in any bone may be discovered, if not by external examination, at least by sawing the bone longitudinally through the suspected broken part, when, should the suspicion be correct, the bony shell will be found thicker and less regular in the situation of the united fracture than in the other parts. So, in such cases, it will be easy to say whether a fracture is recent or of old standing. (See p. 157.)

Locomotion.—With respect to the power of *locomotion* after a fracture, it may be observed, that when the injury is in the arm or in the ribs—unless many of them are broken or the fractures are on both sides—a person may be able to move about, although unfitted for struggling or making great exertion. Fractures of the leg generally incapacitate persons from moving except to short distances. See case by Syme, 'Ed. Med. and Surg. Journal,' Oct. 1836; also another in which one bone of the leg was fractured, and a power of walking some miles was retained. ('Amer. J. Med. Sci.,' Oct. 1845, p. 484.) The reader will find additional information on this subject in the 'Ann. d'Hygiène,' 1839, 2, 241; 1844, 2, 146; and in Friedreich 'Ueber die Knochen in forensischer Beziehung,' Ansbach, 1853.

DISLOCATIONS.

Dislocations are not frequent in the old or in those persons whose bones are brittle. They rarely form a subject for medico-legal investigation. A witness is liable to be asked, what degree of force, and acting in which direction, would produce a dislocation—questions not difficult to answer. They are not dangerous to life, unless of a compound nature, when death may take place from secondary causes. A dislocation which has occurred in the *living body* may be known after death by a laceration of the soft parts in the neighbourhood of the joint, and by the copious effusion and coagulation of blood. For an account of the appearances presented by a dislocation of the

shoulder four days after death, see 'Med. Gaz.' vol. 31, p. 266. If of old standing, a dislocation would be identified by the cicatrices in surrounding structures. Dislocations may occur from *natural causes*, as from disease and destruction of the ligaments in a joint; also from violent muscular spasm during an epileptic convulsion. Dr. Dymock met with an instance of dislocation of the shoulder forwards during puerperal convulsions. ('Ed. Med. and Surg. Journal,' April 1843; see also 'Lancet,' April 1845, p. 440.) A power of *locomotion* may exist, except when the injury is in the lower limbs: but it has been observed that, for some time after a dislocation of the hip-joint, considerable power over the limb remains; it is only after a few hours that the limb becomes fixed in one position. Exertion with the dislocated member is in all cases out of the question.

Detection of fractures. (*Malapraxis.*)—There are certain fractures of an obscure kind which closely resemble dislocations. This has been pointed out by Sir A. Cooper, in relation to fractures of the anatomical neck of the os humeri (arm-bone). ('Guy's Hosp. Rep.' No. 9, p. 272.) This accident might easily be mistaken for a dislocation of the shoulder. ('Med. Gaz.' vol. 36, p. 38.) In attempting to reduce the bone, the head continually falls back into the axilla. In such a case an action for malapraxis might be brought against a surgeon, and heavy damages recovered. It could only be by a dissection of the part after death that the real nature of the case would be ascertained. It is requisite, therefore, that great caution should be used in giving an opinion. The same observations apply to fractures of the neck of the thigh-bone, although with less force, because this is a more common accident. It is well known that fractures and dislocations, when cured, are often attended with some slight *deformity* of the limb, or with some impairment of its functions. This result is occasionally inevitable under the best treatment; but it is commonly set down as a sign of unskilfulness in the medical attendant. An action for malapraxis is instituted, and, in spite of good evidence in his favour, the surgeon is sometimes heavily fined for a result which could not be avoided. There is often great injustice in these proceedings, and the mischief can only be remedied by referring the facts to a competent medical tribunal, which alone should be empowered to decide whether or not unskilfulness had really been shown in the management of a case. The system of allowing each party to select his own medical witnesses invariably leads to a conflict of opinion and evidence.

CHAPTER 49.

GUNSHOT WOUNDS—THEIR DANGER—IN THE LIVING AND DEAD BODY—WAS THE PIECE FIRED NEAR OR FROM A DISTANCE?—EVIDENCE FROM SEVERAL WOUNDS—THE PROJECTILE NOT DISCOVERED—DEFLECTION OF BALLS—ACCIDENTAL SUICIDAL AND HOMICIDAL WOUNDS—POSITION OF THE WOUNDED PESRON WHEN SHOT—WOUNDS FROM SMALL-SHOT—WOUNDS FROM WADDING AND GUNPOWDER—IDENTITY FROM THE FLASH OF POWDER—EXAMINATION OF THE WEAPON.

GUNSHOT wounds are of the contused kind, but they differ from other wounds in the fact that the vitality of the part struck by the projectile is destroyed, and this leads ultimately to a process of sloughing. The legal definition of a wound applies here as in other cases, so that in order to constitute a gunshot wound in a legal sense, the cutis or true skin, must be injured. In *Reg.* v. *Mortlock* (Cambridge Lent Assizes, 1843), the surgeon deposed that there was a circular wound on the skin, by which it had been deprived of its cuticle,

but the true skin was not penetrated. The bullet had struck obliquely at a considerable angle; had it been otherwise, it must have entered the abdomen. The judge said that, as the true skin was not penetrated, there was no wounding within the meaning of the statute.

Their danger.—The medico-legal questions which arise out of gunshot wounds, are similar to those which have been examined in relation to other wounds. They are *dangerous to life*, especially when they penetrate or traverse any of the great cavities of the body. Death may take place directly, either from loss of blood or from shock; although immediate or copious bleeding is not a common character of these injuries. Death from shock is occasionally witnessed. In the case of *Daly*, who was killed by a pistol bullet in Hornsey Wood, May 1842, it was found, on inspection, that the bullet had traversed the distended stomach at the greater end from behind forwards. The two apertures were about the size of a shilling, and the edges black. There was but little blood effused, and the other viscera were uninjured. The deceased died in a few seconds after receiving the wound, obviously from a shock to the nervous system. ('Lancet,' May 1842.) Indirectly, these wounds are attended with much danger; sloughing generally takes place uniformly throughout the whole of the parts perforated, and inflammation or fatal bleeding may cut short life. If the person survives the first effects, he may die at almost any period from suppurative fever, erysipelas, gangrene, or from the results of operations absolutely required for his treatment. Gunshot wounds may thus destroy life after long periods of time. Mr. Longmore records a case in which a man was shot in the right loin at the siege of Sebastopol, on the 16th of April 1855. He died from the effects of the wound on the 13th February 1859, three years and ten months after the injury. ('Guy's Hospital Reports,' 1859, 5, 173.) Marshal Maison, one of the generals of Napoleon I., died in Paris in 1840, as it is reported, from the effects of a gunshot wound received forty years before. Without resting upon the last-mentioned case, instances of gunshot wounds proving fatal after a year and a day are not unfrequent, and they strongly show the inconsistency of limiting the legal responsibility of an assailant by the period at which death takes place. (See p. 569.) In gunshot wounds of a severe kind, the first symptoms by no means indicate the degree of mischief. Thus in the case of Mr. *Drummond*, who was shot by *M'Naughten*, in January 1843, the symptoms were in the first instance so slight, that the bullet was supposed not to have penetrated the cavity of the abdomen, but to have coursed round the skin. Death took place in a few days, and it was then found that the bullet had completely traversed the abdomen, perforating the diaphragm. Army-surgeons have also remarked that slight wounds of the coverings of the abdomen are often insidiously attended with deep-seated injury. Death might in such a case be improperly ascribed to mismanagement, when it may have been really caused by the wound. (See cases by Sir Rutherford Alcock, 'Med. Gaz.' vol. 24, p. 850). It is not easy to mistake a gunshot wound for any other injury. If the circumstances under which it is produced do not satisfactorily account for its origin, a simple examination will generally suffice to show its true nature. Sometimes the projectile, or part of the dress, is found lodged in the wound. Mr. Ward has reported a singular case, in which a perforating wound of the skull, inflicted with a red-hot poker, produced in the bones a small sharply-defined circular opening nearly half an inch in diameter. It bore a close resemblance to a bullet wound. The absence of a bullet showed that it had not been produced by any projectile. ('Med. Gaz.' vol. 44, p. 767.)

In the living and dead body.—A medical witness may be asked whether the wound was inflicted *before or after death*. It is by no means easy to answer this question, unless the bullet has injured some vessel, when the effusion of

blood and the formation of coagula will indicate that the person was living when it was received. If a gunshot wound has been produced in a dead body, no blood will be effused, unless the bullet strikes a large vein.

Was the piece fired near or from a distance?—A gunshot wound produced by the muzzle of a piece being placed near to the surface of the body, has the following characters:—There may be two apertures, the one of *entrance* and the other of *exit*; but it sometimes happens that the bullet lodges and does not pass out. The edges of the aperture of entrance are generally torn and lacerated and appear blackened, as if they had been burnt; this arises from the heat and flame of the gunpowder at the moment of explosion. The skin is often ecchymosed, and is much discoloured by the powder; the clothes covering the body are blackened by the discharge, and sometimes ignited by the flame. If the muzzle of the piece was not in immediate contact with the part struck, the wound is rounded; but if there has been direct contact, the skin, besides being burnt, is torn and much lacerated. The bleeding is usually slight, and when it occurs it is more commonly observed from the orifice of exit than from that of entrance. It should be remarked that the aperture of entrance is round only when the bullet strikes point-blank or nearly so. If it should strike obliquely, the orifice will have more or less of an oval or valvular form; and by an observation of this kind we may sometimes determine the relative position of the assailant with respect to a wounded person. Supposing the bullet to have been fired from a moderate distance, but so near as to have sufficient momentum to traverse the body, then the appearance of the wound will be different. The *orifice of entrance* will be well defined, round or oval, according to circumstances; the skin slightly depressed; the edges presenting a faintly bruised appearance; but the surrounding parts are neither blackened nor burnt, and they do not present any marks of bleeding. In these cases the *orifice of exit* is large, irregular, the edges somewhat everted, and the skin lacerated, but free from any appearances of blackness or burning: it is generally three or four times as large as the entrance-aperture. This is denied by Dr. Malle ('Ann. d'Hyg.' 1840, 1, 458), but, it appears to me, upon insufficient grounds. The orifice of entrance is generally large and irregular when the bullet strikes near the extremity of its range. Under common circumstances, the entrance-aperture may have the appearance of being smaller than the projectile, owing to the elasticity of the living skin. ('Ann. d'Hyg.' 1839, 2, 319.) It is the same with the aperture in the dress, when this is formed of an elastic material. According to Dupuytren, the hole in the dress is always smaller than that made by a bullet in the skin. These points should be remembered in fitting projectiles to wounds which they are supposed to have produced.

Useful evidence may be sometimes obtained by a careful examination of the projectile, which, if found, should be preserved by the medical witness for the purpose of identity. When the projectile cannot be found, and there are no marks of burning, or other signs of a near wound on the skin, we must be cautious in expressing an opinion. In the case of *The King* v. *Howe and Wood* (Stafford Lent Assizes, 1813), it was proved that the deceased had died from a gunshot wound in the back. The bullet extracted from the wound was found to have been discharged from a pistol with a screw-barrel. A weapon of this kind was found on the prisoner, as well as a bullet which had evidently been cast in the same mould as that taken from the body of the deceased. (Wills's 'Circ. Evidence,' 264.) On these occasions, the medical attendant should either keep possession of any of the projectiles which he may remove from a wound, or deliver them only into the hands of responsible persons. An examination of the *dress* alone will sometimes enable us to give an opinion as to where the bullet had passed in, and thus to form a judgment of the direction in which the

shot was fired. If a ball strikes at a moderate distance, the aperture in the dress where it enters, is round and the margin is regularly defined; but the aperture by which it passes out is irregularly torn. In the case of a friend who was wounded in Paris during the Revolution of 1830, the ball traversed the left arm:—it had taken out a circular piece of the coat, shirt, and undershirt, where it had entered; but it produced a large irregular opening where it had passed out. Sometimes portions of the dress are carried into the wound—or, if the ball is nearly spent, the dress is elongated like a pouch into the wound. By putting the edges of the cloth together where the bullet has passed in, it may be seen whether any of the cloth has been carried before it. The holes are generally ragged, but the nearer the wounded person is to the assailant, the more perfect is the hole in the dress—provided the piece be not discharged in immediate contact. The bruised and dark appearance which a gunshot wound sometimes presents, even when the piece is discharged at a distance from the body, led to the supposition that this effect was due to a burn, and that the bullet burnt the parts which it touched; but this idea has been long exploded. The projectile never becomes sufficiently heated to acquire the least power of burning.

The question whether a piece was fired *near to, or at a distance from*, the wounded person, may be of some importance either on a charge of homicide, or of alleged suicide. Two persons may quarrel, one having a loaded weapon in his hand, which he may allege to have been accidentally discharged, and to have killed the deceased. If the allegation is true, we ought to find on the body the marks of a near wound: if, however, its characters were such that it had obviously been produced from a distance, and therefore after the quarrel, medical proof of the fact might imply malice and involve the accused in a charge of murder. The following case occurred in Ireland in 1834:—A tithe-collector was tried for the murder of a man by shooting him. It appeared in evidence that the prisoner, while on duty, was attacked by the deceased and two of his sons, and he drew a pistol to intimidate them. He was dragged off his horse by these persons, and during the scuffle, it is supposed, the pistol was discharged accidentally and inflicted a wound on the deceased, of which he died shortly afterwards. The sons of the deceased swore that the prisoner took a deliberate aim, and fired the pistol at their father when at some distance; and a priest came forward to depose that such was the dying declaration of the deceased. From some doubt of the truth of this story, the body, which had been carelessly inspected in the first instance, was ordered to be disinterred. It was again examined by a surgeon, who was enabled to swear positively that the pistol must have been fired close to the body of the deceased, and not at a distance, since there were the marks of powder and burning on the wrist. Hence it clearly followed that the pistol had not been discharged at a distance, but during the scuffle, either by accident or in self-defence. The prisoner was acquitted, and the parties who had appeared as witnesses against him were convicted of perjury.

In the case of Mr. *Pearce*, a surgeon who was tried at the Central Criminal Court, in 1840, for shooting at his wife, and was found insane, it appeared from the medical evidence that the pistol had been fired so near to the person of the prosecutrix, that her dress was burnt and the skin blistered. Mr. Marshall relates that when stationed at Ceylon with troops, a man, who had but recently joined the regiment, was placed as sentry in a position where he was occasionally fired at by the enemy from the surrounding jungle. The man was one day found severely wounded; the calf of his leg was greatly torn, the whole charge of a musket having passed through it. He attributed the wound to a shot from the enemy: but from the skin of the leg having been completely blackened by charcoal, it was clear that it must have arisen from the discharge of his own

musket. He had inflicted this wound upon himself in order to obtain a discharge from the regiment. These examples, then, show that both the dress and skin of a person who has received a gun or pistol-shot wound should be closely examined. The result may be, that the statement given of the mode in which a wound was received will be entirely disproved. The case of M. *Peytel*, tried in France, in September 1839, furnishes an additional illustration. This gentleman was travelling in a carriage, in company with his wife, and attended by a man-servant. The wife and the man-servant were found dead on the road, and the account given by M. Peytel was, that the servant had discharged a pistol into the carriage and shot his wife, and he had afterwards pursued and killed him. The facts, however, were so suspicious against M. Peytel, that he was charged with the double murder. From an examination of the body of the wife, it appeared that there were two pistol-wounds in the face, which had most probably been produced by two separate pistols. The prisoner alleged that about nine o'clock at night, when it was dark, he desired the servant to get down and walk in order to relieve the horses. Two minutes afterwards, some man, whom he found to be the servant, approached the carriage-door, discharged a pistol at him, and wounded his wife; but the evidence showed that two weapons must have been used, or at least two different discharges made by a person sitting very near to the deceased, so that the muzzles must have almost touched her face—the eye-lashes and skin having been much burnt by the powder. These facts, together with other strong circumstances against him, led to the prisoner's conviction. The late Dr. Ollivier, who appeared in the prisoner's defence, considered that the deceased might have been shot by the servant, and that the two wounds might have been produced by one pistol loaded with two bullets; also, that the marks of burning about the face of the deceased might be attributed to the wadding, and, therefore, they afforded no proof that the muzzle of the pistol had, at the time of its discharge, been close to her person. He further contended that the deceased had not died from the wounds. Notwithstanding these ingenious suggestions, there can be no doubt that the prisoner was properly convicted. (See 'Ann. d'Hyg.' 1839, 2, 339; 1842, 1, 368.) The amount or degree to which the clothes and body of a person may be burnt by the near discharge of firearms has given rise to a medico-legal inquiry. A fact of this kind can only be determined by the circumstances of each case. ('Ann. d'Hyg.' 1860, 1, 125.)

It has been said that when a bullet is fired near, it commonly traverses the body; and therefore it has been rather hastily assumed, that when there is only one external wound, and the bullet has lodged in the body, this is a proof that the piece has been fired from a distance. This inference is, however, erroneous. A bullet may be fired close to a person and yet not traverse the body, either from its impulsive force not being sufficiently great, or from its meeting a great resistance in its course. Many cases might be cited to show that, in the near wounds produced by suicides and murderers, the bullets have not always traversed the body. In suicide, when the piece is discharged into the mouth, the projectile often lodges in some part of the head.

Evidence from several wounds.—When several wounds are found on a body, can we determine whether they were produced by one or several different discharges? This question was raised in *Peytel's* case, as there were two wounds on the deceased, and the prisoner alleged that the servant had fired but one pistol. M. Ollivier thought that this might be explained by supposing that there had been two bullets in the pistol:—it was, however, affirmed by some military officers and other witnesses, that these wounds had been produced by separate pistols—a fact which overthrew the defence of the prisoner. ('Ann. d'Hyg.' 1843, 1, 368.) It is proper to remark that one ball may sometimes produce several wounds on the body; there will be only one orifice of en-

trance, but, owing to the ball occasionally splitting within the body, and dividing itself into three or four pieces, there may be several orifices of exit. This splitting of a ball has repeatedly occurred when the projectile in its course has encountered an angular surface, or a projecting ridge of bone. Dupuytren met with an instance, in which a ball, after having struck the ridge of the bone of the leg (the tibia), divided itself into two parts, which traversed the calf of that leg, and penetrated into the calf of the opposite leg. Thus no fewer than five wounds were produced in one instance by a single ball—three of entrance and two of exit. Had this man been found dead, and nothing known concerning him, this singular circumstance would probably have given rise to considerable embarrassment. After a careful examination, a surgeon might have been induced to declare that this person must have received at least three distinct shots. A similar effect was observed in another case, in which the bullet struck the parietal bone of the head and divided itself into two portions:—one passed out superficially through the skin, the other penetrated into the brain, and lodged on the tentorium. This fact shows that the discovery of an exit-aperture does not always prove that the whole of a projectile has passed out—a matter which may influence a medical opinion as to the result.

In the case of Mr. *Drummond*, who was shot by *M'Naughten* in 1843, the pistol was discharged close to the back of the deceased. The ball, however, had not traversed the body, but had lodged beneath the skin in the forepart of the abdomen. In the case of *Latham*, shot by *Buranelli* in 1855, although the pistol was discharged close to the deceased, the bullet lodged in the second vertebra of the neck, where it was found after death. It is then, it appears to me, out of the power of a witness to say from the mere fact of a bullet lodging or traversing, whether the assassin was far off or near at the time the deceased was wounded. The latter point may be sometimes readily determined by the marks of injury and burning about the skin and dress. When a gun or pistol is discharged at the distance of three or four yards from the person, it will not, of course, produce those marks of blackening, burning, and bruising on the skin which are found when the muzzle is within a few inches of the body. Such a wound may remove a suspicion of suicide, and create a strong presumption of homicide. Dr. Lachèse found that in firing a gun at the distance of four feet, the skin was only partially blackened. It would be very important in a case of this kind to notice the direction of the wound as well as the relative position of the assailant and assailed, as stated by witnesses or deduced from circumstances. In this respect the facts connected with the death of *Charles XII. of Sweden* are of some interest. On the night of the 11th of December 1718, the king, who was besieging the fortress of Fredericks-hall, during an examination of the works, clambered up a mound facing the enemy's batteries and within reach of their fire. There were with him, but at different distances from him, several noblemen. Suddenly the king gave a deep sigh, and fell dead on the parapet, with his face towards the fortress. A ball had struck him on the right temple, traversed the brain from right to left, and forced the left eye from its socket. The direction of the wound tended clearly to prove that the king was not struck by a ball from the battery which he was facing, but that this had been fired from some person on his right hand. Suspicion fell upon a M. Siquier, who was at that time in attendance on the king: whether this was well founded or not, there can be but little doubt that the king was assassinated.

The projectile not discovered.—It is not absolutely necessary for the conviction of a person on a criminal charge of maliciously shooting at another, that the bullets or shot should be produced, or that they should even have been found on a post-mortem examination of the body. In the case of *Reg.* v. *Cottrell*, tried in 1839, the deceased was seen to drop, and his face was covered

with blood. On persons going up to him he was found dead. The medical evidence established that there was a gunshot wound in the left eye, leading to the brain, and that this had caused death. The shot could not be found. The prisoner's counsel objected, on this ground, that there was no proof of a gunshot wound having been inflicted; but the judge held that the circumstances were sufficient to warrant the jury in inferring that the deceased had been struck by some substance from the gun, which had caused his death; and it was not necessary to prove whether this had been done by leaden shot or pellets. If, however, it should happen that no wound was produced by the discharge, there would be a want of evidence as to whether the piece was loaded or not, and the accused would probably escape on this ground, unless he were very near to the party whom he attacked, or the bullet were discovered. This subject gave rise to much discussion in the case of *Reg.* v. *Oxford* in 1840. By this case it seems to have been decided that the proof of a piece being loaded with ball or shot is not necessary, provided the prisoner were so near to the party when he fired it, that mischief might be done by the wadding or gunpowder only. This, as we shall presently find, becomes occasionally a medical question.

Was the piece loaded with ball?—At one of the trials which took place for an attempt on the life of the Queen, it was asked whether it were possible to determine if a recently discharged gun or pistol had been loaded with ball or not. It is impossible to give an answer to this question, merely by an examination of the weapon. The report, if heard, is said to be louder and sharper in the case of a piece loaded with ball, than when it is charged with gunpowder and wadding only. If a piece were fired in a direction so that the projectile met with any hard or resisting object, the fact of a bullet having been used would be proved, if not by the discovery of a flattened projectile, by the trace of a deep leaden mark in the situation of the part struck.

Deflection of balls.—When a ball traverses the body, it sometimes happens that the two apertures are opposite to each other, although the ball may not have taken a rectilinear course between them, but have been variously deflected by the subjacent soft parts. This deflection of a ball from a rectilinear course is met with in those cases in which it happens to strike obliquely a curved surface, and it is found that when the ball enters and does not pass out, its course is often circuitous, so that it is not always easy to say in what part of the body it will be found. In 1830, I saw at the Hôtel-Dieu, in Paris, a boy who had received a gunshot wound in the upper part of the abdomen: the entrance-orifice was plainly situated there, but there was an opening at the back, nearly diametrically opposite, out of which the ball had passed, so that it conveyed the impression that the ball had completely traversed the abdominal cavity. There was, however, no sign of collapse or depression, nor any indication of serious injury; and Dupuytren gave an opinion, which was afterwards verified, that the ball had not penetrated, but had been deflected beneath the skin, and had taken a circuitous course through the cellular membrane to the back. Many similar facts are recorded. The same deflection may occur even when the piece is discharged close to the body, as in cases of suicide. Mr. Abernethy was once called to examine a man, who had shot himself, as it was supposed, through the head. He found two openings in the scalp, nearly opposite to each other; it was soon perceived, on examination, that the ball had not penetrated the bone, but had followed the curve of the exterior of the skull to its point of exit. The deflection of projectiles may occur not merely when they come in contact with bone, but when they meet skin, muscles, tendons, or membranes; the ball then takes its course in the spaces between these different structures. A ball which entered at the ankle has been known to make its exit at the knee; and another, which entered at

the back of the left shoulder, passed down on the inside of the scapula, and was found below the right ear. This deflection of a ball by slight obstacles has been ascribed partly to the obliquity with which it strikes, and partly to the rotatory motion on its axis which every spherical projectile is considered to have. It does not appear to be much connected with the degree of velocity, for the same deviation has been found to occur when the bullet was fired near or at a distance.

If we can at any time discover two fixed points where a ball has touched a building without being deflected, it will be easy to determine the *situation* from which the piece was discharged. An illustration of this is given by Mr. Watson. The case occurred at Ayr in 1831. Several shots had been maliciously fired into a church. Some of the bullets traversed a window, making holes in the glass, and struck against a wall on the other side of the church—a fact plainly indicated by the marks which they left. A straight line carried from these two points reached a window on the opposite side of the street, from which it was afterwards ascertained the bullets had been fired. In a case tried at the Kingston Lent Assizes, 1862, a similar piece of evidence clearly showed that a gun loaded with a bullet had been maliciously discharged with a design to kill one of two persons. The prosecutrix and her mother were sitting by candle-light one evening near a window in their house, so that their shadows were projected on the blind: a bullet passed through the window and struck the wall of the house inside. A line drawn between these points was about half an inch over the head of the prosecutrix, and about one inch below the level of her mother's head. Neither was hurt. The prisoner was connected with the act by his having been seen near the spot, and by a variety of circumstances. With that contempt which counsel sometimes show for the common-sense of jurymen whom they have to address on these occasions, it was alleged in defence that the prisoner had gone out with his gun (in the evening) to shoot birds (with bullets), and that the piece had been discharged by some accident! The fact that the prosecutrix had not been hit was, he contended in favour of the view of an accidental discharge! The learned judge directed the jury to consider with what intent a shot could have been fired so as to come within half an inch of the head of a person. The prisoner was convicted.

Survivorship.—A witness may be asked, When was the gunshot wound inflicted, and how long did the wounded person *survive* after receiving it? Like other wounds, a gunshot wound undergoes no change for eight or ten hours after its infliction. Our judgment in reference to these questions may be assisted by observing the parts which are involved, although we cannot always infer from the quantity of blood found near to a body, that the bleeding was an immediate consequence of the wound, or that the whole of the blood was effused at once. We cannot, then, always affirm that the deceased could not have moved or exerted himself in some degree after receiving it. The exertion thus made subsequently to his being wounded may have actually caused the fatal bleeding.

Suicidal and Homicidal Gunshot wounds.—When it is doubtful whether the wound was the result of suicide or homicide, the point may be sometimes determined by paying attention to its situation and direction. *Suicidal* gunshot wounds are almost always directed to a vital part—to the heart or to the brain: they possess those characters which belong to wounds inflicted near to the body. The skin is discoloured or burnt, the wound wide and lacerated, the hand which discharged the weapon often blackened, and sometimes still grasping the pistol. The ball may or may not have traversed, as this will depend on the momentum which it derived from the charge, and the resistance which it experienced. (See *The Queen* v. *Thomas*, Brecon Lent Assizes,

1845.) The situation in this instance negatived the supposition of suicide. Suicidal gunshot wounds are seldom situated at the back of the body; therefore the determination of the point of entrance, if the ball has traversed, is of some importance. The direction of these wounds is probably of less moment than their situation, because the projectile is liable to be deflected in the body. In a duel which occurred in Paris, in 1827, one of the parties, a tall man, was killed by a ball which was found to have entered below the right shoulder, and to have taken a direction downwards. In consequence of this, it was thought that he had been shot unfairly by his antagonist, who was short in stature. Breschet and others explained the suspicious course of the wound by assuming that the ball had struck the under part of the clavicle, and had thence probably been deflected downwards. This question excited considerable interest at the trial of a Dr. *Smith* for the murder of a *William Macdonald*, at St. Fergus, in Scotland (High Court of Justiciary, Edinburgh, April 1854). It appeared from the evidence that the deceased was found dead in a field belonging to the prisoner, on the morning of Sunday the 20th November 1853. The body, according to the testimony of eyewitnesses, was lying at full length on its left side in a ditch. The left arm was partly beneath, and the right partly across the body. There was a blackened wound or hole in the cheek, and a little blood on the cheek. A pistol was lying on the ground, according to one witness, about four feet from the head of the deceased. The time at which the deceased died was fixed with tolerable precision at twenty-five minutes before eight o'clock on the evening of the 19th November; and although the prisoner was not seen near the spot, there was evidence that he had made an appointment to meet the deceased that evening, and the testimony of many witnesses showed that he had had an opportunity of being on the spot at the time when the discharge of a pistol had been heard. The defence was, that this was an act of suicide. The pistol could not be identified as belonging to the prisoner; and one witness for the defence positively swore that, six years before, he had sold to the deceased a pistol resembling that found near his body! Upon this statement, and upon the failure of the medical evidence to throw any light upon the important question of homicide or suicide, the prisoner was discharged on a verdict of Not Proven. ('Med. Times and Gazette,' April 22 and May 20, 1854.)

It was proved by the two medical witnesses who gave evidence at this trial, that deceased had died from a pistol-shot, the bullet having penetrated the brain. From the characters of the wound, one thought that the muzzle of the pistol, when discharged, must have been within from three to twelve inches of the face. He admitted that, as an act of suicide, the body might have assumed the position in which it was found, but that the probabilities were against it. The other witnesses thought that the pistol, when discharged, might have been twelve or thirteen inches from the face; and although a person standing could, in his opinion, have made the wound that appeared on the cheek, yet a suicide would probably have made more sure of his aim, by selecting another position. The only information regarding the wound was, that it was in the right cheek, below the malar prominence; that the opening was blackened, and the nose scorched with gunpowder. It appears that the medical witness did not see the body until after the lapse of *two days!* It had in fact been removed from the spot, washed, dressed in grave-clothes, and put into a coffin, before they saw it. (Letter by Dr. Gordon, 'Med. Times and Gaz.' May 20, 1854, p. 525.) Thus the marks of gunpowder on one of the hands, generally found in suicide by pistols, were not seen here; and the removal of the body from the spot placed the medical men in a difficulty, since they could base their opinions only on the statements of ignorant witnesses. There were marks of blood on the ground, but these, it was suggested, might have been accidentally caused during the re-

moval of the body. The situation of the wound, *i.e.* below the malar prominence in the cheek, is rather unusual for an act of suicide, but it was such as a murderer walking by the side of the deceased could have easily selected. The distance at which the pistol was held appears to have been greater than we usually find in cases of suicide; for had it been close, as it usually is in suicide, there would have been marks of extensive burning and laceration of the soft parts about the wound. The position of the pistol with respect to the dead body, as described by the witnesses who found it, is inconsistent with the supposition that deceased had thus fallen accidentally after having himself discharged the pistol. There was no motive for suicide, and no reason why, had suicide been contemplated, the deceased should have selected the prisoner's field for perpetrating the act. Deceased had been seen transacting business within half an hour of the time at which he must have died; and it was stated by his friends that they had never seen him with a gun or pistol in his possession, and had never known him to use fire-arms. Every fact, medical or moral, tended to prove that this was an act of homicide and not of suicide: further, there was no mark of struggling or scuffling, and no robbery had been perpetrated. The motive suggested by the prosecution against the prisoner, was based on the fact that he had recently effected insurances to the amount of about two thousand pounds in three different offices, upon the life of the deceased, without having any pecuniary interest to justify the act. The insurances were for short periods, and it appears to be the practice in the Scotch offices that the policy is not rendered void by the act of suicide. It is important to state, as a supposed motive for the act, that the risk connected with the largest insurance (for one thousand pounds) commenced on the 24th November 1852, and terminated on the 24th November 1853. Only one premium to the amount of about eleven pounds had been paid, and this payment was proved to have been made by the prisoner Smith. The deceased was found dead on the 20th November, *i.e.* only four days before the date at which the policy of insurance upon his life would have lapsed. The accused had thus the motive, means, and opportunity of committing the crime, but there were no circumstances which could directly connect him with it. The early interference with the body, and the neglect to call for a medical investigation, probably led to the obliteration of parts of the evidence which would have clearly satisfied the jury that this could not have been an act of suicide.

Accidental gunshot wounds bear the characters of near wounds: they may touch vital parts, but, if the body has not been disturbed, the presence or absence of design in the infliction of a wound is commonly made apparent by the relative position of the body and the weapon. They frequently arise from persons drawing the charges of guns or pistols with the muzzles pointed towards them, and they are then situated in front: at other times they are produced by persons pulling towards them through a hedge, or dragging after them, a loaded gun. In the latter case the wound is behind, and it may strongly resemble a homicidal wound, although the circumstances under which the body is found generally suffice to explain the matter. (See 'Ann. d'Hyg.' 1860, 1, 443.) In the following case of attempted suicide, the characters of the wound somewhat resembled those which are commonly imputed to homicide. In March 1844, a man was brought to Guy's Hospital, with a large ragged gunshot wound on the right side of the head, behind the angle of the jaw, and between it and the ear. No slugs or bullets could be found; the direction was from behind forwards and from above downwards. According to this man's statement, the pistol missed fire three times, but he succeeded in discharging it into his mouth at the fourth attempt. He lost a large quantity of blood, but after some time he walked to a table at the distance of five yards, reloaded the pistol, and discharged it at the back of his head in the situation described. Thus, then, there

were in this case two wounds, one of them being apparently homicidal in its characters; and there was a power of locomotion after the first wound, in spite of great loss of blood. A gunshot wound in the mouth or temple would seldom be set down to accident, and yet attempts are occasionally made to ascribe to such wounds an accidental origin. The admission of a near wound in the temple occurring from accident, must depend entirely upon the circumstances proved. (See the case of *Reg.* v. *Tottenham*, Norwich Lent Assizes, 1845.)

In suicide there is commonly strong evidence of design; in accident all evidence of design is wanting. Suicides sometimes make use of extraordinary weapons, or use weapons in an extraordinary manner. In a case that was brought into St. Thomas's Hospital, some years since, a young man employed, for the purpose of shooting himself, the case of an Italian iron, in which he had filed a touch-hole. He used a marble for a bullet, and discharged the piece into his mouth. Guns are rarely used by suicides, and when they are employed, the marks of design are commonly apparent: thus the gun is perhaps found to have been discharged by a piece of string attached to the trigger and connected with the deceased's foot. In one instance a man loaded a gun, and placed the stock and breech in a grate. He then deliberately lighted a fire in the grate, and sat opposite to the muzzle. When suicides destroy themselves by guns, the wounds are never situated behind. A wound in the back from a gun, indicates either accident or homicide. Important medical questions sometimes arise out of a case of this kind, for the circumstances under which a dead body so wounded is found, may entirely forbid the supposition of accident. In the case of *Rex* v. *Adams*, tried at the Berkshire Assizes, 1836, in which the prisoner was charged with the murder of his father, the gunshot wound which had caused death was situated at the back of the head. No weapon was found near, hence there could be no doubt that this was an act of murder. The prisoner was acquitted; since, although he was seen running from the spot at or about the time of the murder, another gun was heard to be discharged from the same spot about an hour afterwards; and it was impossible, from a medical examination of the wound, to say at what particular period it had been caused. A somewhat similar case occurred subsequently (*Reg.* v. *Richards*, Warwick Lent Assizes, 1843). The deceased was found dead, lying on his back, with his gun placed on the front of his body, reaching from his thigh to some inches above his head. On inspection, it was ascertained that death had been caused by a severe gunshot wound at the back of the right ear. Two surgeons of Birmingham gave it as their opinion, that, from the position of the wound, the body and the weapon, death could not have occurred from design or accident on the part of the deceased, but might have taken place from the accident of another. The prisoner was acquitted, as there was insufficient proof to connect him with the act.

There is one circumstance to be noticed in reference to suicide by fire-arms. If a man has really discharged the piece at himself, whether it be a gun or a pistol, the injury should present the characters of a near wound—indicated by blackening and lividity of the skin, with a bruising and laceration or burning of the soft parts. A remarkable case was tried at the Shrewsbury Autumn Assizes, 1870 (*Reg.* v. *Wilson*), in which a young medical student was charged with shooting at his father, a medical man, with intent to murder him. The prosecutor was lying asleep on a sofa in the evening, when he was suddenly awakened by a report of fire-arms, and the sensation of an acute burning pain in the eye. This was followed by another report. He was unable to see for the moment, but fancied he heard the sound of footsteps between the two reports. A bullet was subsequently extracted from the eye and another from the head. He fell off the sofa, and in raising himself up found a revolver on the floor at a short distance in advance of him. This was proved to be his own revolver. The prisoner

had shortly before this gone down-stairs in the direction of the room where his father was lying asleep. The prisoner called to his sister, saying that his father had shot himself. The medical evidence clearly showed that this was not such a wound as would have been produced by an attempt at suicide. It had none of the characters of a near wound. The prisoner had had some disputes with his father, but there did not appear to be a sufficient motive for such an act, although he had the means and opportunity. He was acquitted of the charge. It was suggested that some person might have entered the house and fired twice at the prosecutor while he was asleep, although there was no motive for shooting a sleeping man. The statement made by the son, that his father had shot himself, was proved to be untrue by the nature of the wounds.

Evidence from the position of the body and the weapon.—Due allowance must be made for the singular conditions under which the bodies of persons who have committed suicide by fire-arms may be found, or erroneous suspicions of murderous interference may be formed. Mr. Jordan, of Manchester, communicated to me the particulars of the following case to which he was called in December 1868. A man was found dead on the floor of his bedroom, his body stretched out at full length; both arms were lying straight close to the sides of the body. A pistol-case was at a short distance from his right hand, and the left was gently closed on a piece of burnt paper without any blood on it, and the insides of the fingers were blackened. The pistol was lying near the *left* hand. On the right temple there was a deep wound having the characters of an entrance wound, which had traversed the head completely. Portions of brain and blood had been carried to the left side, covering some of the furniture beyond the body. On this side, too, a conical bullet was found within the fender. It resembled those in the pistol-case.

This was an act of suicide. The discharge of the pistol was heard in an adjoining room by a servant, who stated that she heard the man speak immediately after the discharge of the pistol. The position of the pistol and the laid-out attitude of the body, the arms and hands close to the sides, might have fairly given rise to a suspicion of murder. The fingers of the left hand were blackened, but it is impossible to conceive that such a wound could have been inflicted on the right temple with the left hand, and then the question would arise, How came the burnt paper (wadding) in this hand? If the pistol was discharged with the right hand, then how did it happen that the pistol was lying near to the left hand on the left side of the body, while the right arm was stretched at full length on the right side of the body. It is probable that the man shot himself with his right hand while sitting on the floor; that the pistol dropped on his left side, and that he fell flat on his back, retaining sufficient power to place his arms by the sides of his body. The burnt paper and the blackening of the fingers remain to be explained. The left hand must have been held near the pistol when it was discharged.

In these cases, as in cases of actual murder, there are many mysteries which can only be unravelled by the person committing the crime. Such a case as the above might have easily given rise to a charge of murder, and on highly plausible grounds. All that was required was, that some one having an apparent interest in the death of the deceased should have been seen near the spot about the time of the occurrence!

The case of *Risk Allah* will furnish an additional illustration. A young man named *Readly*, to whom the accused was related by marriage, and by whose death he would inherit some property, was found dead in his bed at an hotel in Antwerp, in March 1865. Readly was subject to epileptic fits; he had recently had a disappointment in reference to marriage. Risk Allah had insured the deceased's life for 1,000*l.*, but that was in order to cover a loan which he had made to him. The facts, as they transpired from an official inquiry at

Antwerp, were these:—On the morning of the 30th March 1865, deceased had an epileptic fit, and his companion, Risk Allah, who was in the medical profession, having attended to him, left him to sleep—he himself sleeping in a corridor at some distance from deceased's bedroom. At 7 o'clock on that morning the chambermaid had gone into deceased's room and had seen him asleep. At 7.30 Risk Allah was seen to come down-stairs and to go out of the house, to which he did not return until just before 9 o'clock, when the landlord said that as they had neither seen not heard anything of Readly since his fit, Risk Allah had better go and see how he was. The bed-room door was found fastened on the inside, and there was a strong smell of gunpowder-smoke issuing from the keyhole. He immediately called for assistance. The door was broken open, and it was found, on entering, that furniture had been placed against it, and the room was full of smoke; a table and chair were found overturned. The deceased was lying on the bed, shot through the head. The body was naked, the night-dress which he had worn being in another part of the room, without any stains of blood upon it. Blood was still flowing from the wound, and one of the hands was warm. The right arm was across his stomach, and his left arm was lying by the side of his body. The left hand was almost out of the bed. A recently discharged gun and a ramrod were on the floor by the side of the bed, and there was a chair close by, which had been overturned. Some shots were also found. On a table in the room was a piece of paper on which was written, in the handwriting of the deceased, the words 'I have done it,' the ink being still *wet*. A trial took place and the question was raised, Whether this was an act of murder or suicide? After three days' investigation Risk Allah was discharged, and the act was pronounced to be one of suicide. Three years afterwards the whole case was gone into again in this country, on the occasion of an action for libel, in which the writer substantially charged Risk Allah with the murder of his companion (*Risk Allah* v. *Whitchurch*, Q. B. June 1868), and a verdict with heavy damages was returned for the plaintiff. Apart from the fact that the accused was not proved to have been on the spot when the deceased received his death-wound—that the doors of the room were fastened on the inside—that the body when found was warm and the blood was still oozing from the wound (not coagulated), showing thereby very recent death—that the ink on the paper with the words 'I have done it,' was still wet, and proved to be in the handwriting of the deceased, there was another circumstance pointed out by the learned Chief Justice (Cockburn) on the trial for libel. The body was found naked on the bed, the night-dress being in another part of the room, not stained with blood. This seemed only consistent with suicide. Deceased slept in a night-dress, and was seen with one on that night. If shot by the hand of another, it cannot be supposed that the murderer would have taken off the night-dress and stripped the deceased naked before firing the gun. Had it been possible to do this without causing a struggle and raising an alarm, there could be no conceivable motive for such an act. On the other hand, the deceased might have removed it to prevent its catching fire; but whether this was or was not the motive, the deceased himself must have taken it off and placed it where it was subsequently found.

The position and attitude of the dead body were considered by some medical men to be inconsistent with suicide. One who was examined said that after a severe gunshot wound like this, involving the brain, it would be impossible for a person to place his arms by the sides of the body or to put his hands under the bedclothes! Another contended that a man could not possibly shoot himself with a gun while lying down in bed; but both of these propositions are contrary to fact. In the case of suicide related at p. 675, the arms were found straight down on each side of the body, the wound in that case traversing the brain and causing almost instantaneous death. In reference to the second point there

have been many instances of soldiers destroying themselves by firing the gun while lying down, by means of the ramrod, which appears to have been used for this purpose by the deceased; and in order to satisfy the jury one of the military experts for the defence, at the Antwerp trial, lay down on a bed in court and fired a gun by means of a ramrod! It was also proved at the trial that the wound in the body had the usual appearances of a near wound which would be the result of a gun so fired. In short, there was nothing in the *medical* circumstances of this case which justified the charge of murder.

In relying upon the relative position of a discharged gun or pistol to the deceased, an expert, unless he has had a large experience in such subjects, may be easily deceived, and draw a false, and to the prisoner a damaging conclusion. In September 1869, Dr. Mackintosh, of Downham, communicated to me the following case:—A gentleman was out shooting with a double-barrelled gun. He had just put on the percussion-cap, and was holding the gun loosely in his hands, when owing to an accident the right barrel went off. From the recoil, with nothing behind the butt, the gun flew back a yard or two behind him, and the cap of the left barrel came so sharply in contact with the hard ground, that it also exploded, sending the charge into the outside of the sportman's thigh. The shot passed through the right-hand pocket of his shooting-jacket, striking his shot-bag, and driving the brass-top into the muscles behind the hip joint. The metal head of the shot-bag deflected the charge, so that it passed round outside the thigh and lodged in the muscles. This deflection probably saved his life, as no great vessel was wounded. Assuming that the man had been found dead under these circumstances, an expert would probably have come forward to say, as in Risk Allah's case, that suicide and accident were impossible. No man could have shot himself with a gun from behind in the manner described, and the position of the gun one or two yards behind the body could only be explained on the supposition that some one had shot the deceased from behind!

A case of some interest in reference to the attitude of the body and position of the weapon, in death from a pistol-shot wound, is reported by Dr. Horteloup in the 'Ann. d'Hyg.' 1868, 2, 445. M. Toulmouche has also contributed to the same journal several cases illustrating the effects produced by bullets and small-shot under different conditions. ('Ann. d'Hyg.' 1867, 1, 403.)

Position of the wounded person when shot.—Did the deceased receive the shot while standing, falling, or lying down? Was the piece, when discharged, pointed from the shoulder?—These questions can only be answered by reference to the particular circumstances of each case. In general, when a person is shot while standing, and the piece is pointed from the shoulder, the wound is more or less transverse; but due allowance must be made for the deflection of balls after penetration. (*Reg.* v. *Magarity*, Central Criminal Court, July 1841.) Was the deceased shot while running away, or when approaching the person who fired?—This question is answered by observing, in the case of a traversing wound, in which alone any difficulty can arise, whether the entrance-orifice be situated in front or behind.

A trial took place at the Kent Assizes, some years since, in which this question was material. An officer in the Preventive Service was charged with having caused the death of a man, by shooting him. The deceased was in company with a strong party of smugglers, whom the prisoner and his men were pursuing. During their retreat, the companions of the deceased fired on the Preventive Service men, and there seemed great reason to believe that he was accidentally killed by one of the shots so fired, as he was at that time between the pursuers and pursued. If, however, this had been the case, it was clear that he must have received the gunshot wound in front, as he himself was in the act of retreating. On the other hand, it was uncertain, from the

general evidence, whether he had not been shot by the prisoner; because, although it did not appear that shots had been fired by him or any of his party, yet it was proved that in running he tripped and fell, and his gun went off at the same instant, so that it was not impossible the deceased might have received the mortal wound in this manner. The whole case, therefore, rested on the medical evidence. Two surgeons were examined, one for the prosecution and the other for the defence. The witness who appeared for the prosecution deposed that he found the body of the deceased traversed by a gunshot wound, which had caused death from the laceration of an artery, and the consequent hæmorrhage. One of the orifices of the wound was situated in the lower part of the buttock, and the other in the upper part of the groin, so that the latter was higher up than the former. He made an inspection of the body, and in his judgment the ball had passed through the bones of the pelvis, from behind. According to the opinion of this witness, therefore, the prisoner must have caused the death of the deceased. For the defence, a surgeon in the navy—who, it appeared, had had considerable experience relative to gunshot wounds—was called. He stated that he examined the body of the deceased in the presence of the first witness, but he was of opinion that the ball had entered in front, and passed out behind the body. The reasons which he assigned for this opinion were, that the wound in front was much smaller than that situated behind, and its edges were smooth and depressed, or turned inwards; while the opening behind was twice or three times the size of that before, and was ragged and uneven—the fragments of bone lying about the opening, and being partly lodged in the muscles of the buttock. These facts proved to him, most unequivocally, that the ball had entered in front, having, with diminished impetus, torn itself out posteriorly. If the ball had entered from behind, he should have expected that the fragments of bone would have been carried upwards and inwards into the pelvis, and would not have been lodged about the buttock. The value of this witness's evidence was most materially affected by the cross-examination which he underwent. He then stated that he did not make an inspection of the body until after it had been already inspected, and sewn up. He did not see the state of the bone itself, and his examination of it was but slight. He admitted that the openings of the wound afforded better evidence than the state of the bone, as also that the bone would certainly be shattered where the ball had entered. They had both agreed, in the first instance, that the ball had entered in front. No reason was assigned why the evidence of his colleague differed so materially from that which he gave. Dr. Smith, who reports this case, does not say what was the result, and we are, therefore, left in doubt upon which of the two witnesses' opinions the verdict of the jury was based; but if it was found that the accused had been the cause of the death of the man, it would have been, upon the evidence, no more than misadventure. The view of the latter witness was most probably correct, namely, that the ball had entered in front, and that the deceased was shot by his own party—because the reasons assigned by him were satisfactory and consistent with general experience on the subject; but his opinion was invalidated by the admission that he had made but a superficial and imperfect examination of the body, as also that he did not see it until after it had been inspected, and therefore not until the parts had been interfered with by others. The direction of the wound—its passing from above downwards, and from before backwards—also throws a shade of doubt upon its correctness; since, for the shot to have been fired in front, the individual who fired it must have been much elevated above the deceased (a circumstance which did not appear from the evidence), or a ball could not have taken such a course; while, on the other hand, its direction was precisely such as it would have taken if it had been discharged from the prisoner's gun, since it was estab-

lished by the evidence that the accused had fallen while pursuing, and his gun had become then accidentally discharged. (Smith's 'Forensic Medicine,' p. 290.)

Wounds from small-shot.—Death is sometimes occasioned by small-shot, and here several medico-legal questions present themselves. Small-shot may act in two ways:—1. It either strikes without spreading, in which case the discharge is always near the person, and its action is much more dangerous than that of a single ball, because it produces extensive lacerations; or 2. It strikes after it has spread, and here the discharge must have been distant, and comparatively little mischief is done. Dr. Lachèse found, by many experiments on dead bodies, that in order to produce with small-shot a round opening, somewhat resembling that produced by a bullet, the discharge should take place point-blank at the distance of not more than ten or twelve inches from the surface of the body. When the distance was from twelve to eighteen inches, the opening made was irregular, and the borders were much lacerated; at thirty-six inches, a central opening was entirely lost, and the surface of the body was covered by the scattered shot. The effect after this was found to depend on the distance, the goodness of the gun, and the strength of the charge ('Ann. d'Hyg.' 1836); but the shot is, in general, much scattered over the surface of the body. A medical witness may be required to form an opinion of the distance at which a gun was fired. In *Reg.* v. *Chapman* (Oxford Lent Assizes, 1839) it was proved that the deceased had been killed by small-shot fired from a gun; that the discharge must have taken place very near, as the shot had not been scattered, and the point of the gun must have been below the level of the wound, as the direction was rather upwards. Two medical witnesses were examined, and both agreed that, judging from the direction of the wound, the gun when fired could not have been pointed from the shoulder. A similar question was raised in *Reg.* v. *Hull* (Oxford Summer Assizes, 1846), and it was decided that the discharge of the gun took place accidentally during a struggle. The case of *Reg.* v. *Kendrew* (York Winter Assizes, 1844) is in this respect of some medico-legal importance. The medical evidence was very satisfactory. It was shown to be highly improbable that deceased could have shot himself with small-shot from a gun, as the shot were scattered, and there was no round opening or mark of burning. It is difficult to conceive that small-shot could produce a single entrance-wound, having an appearance of circularity about it, without at the same time singeing or burning the skin or dress.

The difficulty of laying down any general rules respecting the wounds produced by small-shot at their entrance and exit, will be apparent from the following facts, communicated to me by two medical gentlemen:—A boy was shot in the neck by the accidental discharge of his gun, loaded with an ounce of No. 8 shot. He died instantly. He was leaning forwards on the muzzle, so that it was nearly in contact with the skin of the neck. A large round hole was produced, one inch and a-half in diameter, the edges of which were slightly blackened with powder. The exit-aperture, which was at the back of the neck, a little to the left of the third cervical vertebra, was a mere slit in the skin, scarcely an inch long, with the long diameter placed vertically. The smallness of this aperture may have been owing to the greater part of the charge being lodged in the body. The entrance-aperture, although rounded, was too large to be mistaken for a bullet-wound: it was evidently a near wound, from the blackening of the edges. On the other hand, Dr. Lowe informs me that in some experiments performed by his brother, it was found that a round aperture might be produced by the discharge of small-shot at a much greater distance from the object than that assigned by Dr. Lachèse. A new gun was fired with the usual charge at a sheet of paper placed at sixty paces' distance.

A circular hole was produced in the centre of the sheet, through which apparently every shot had passed. The hole was slightly jagged at the edge, but otherwise resembled that made by a bullet. My informant believes that new guns with highly polished surfaces throw the shot very closely together, and that this is the explanation of the difference in the results obtained by him and those described by Dr. Lachèse. Admitting such exceptional instances, and assuming the general correctness of the inferences drawn by Dr. Lachèse, from the results of his experiments in discharging small-shot at dead bodies placed at different distances, it does not seem probable that a wound from small-shot could, under any circumstances, be mistaken for one produced by a leaden *bullet*. This question arose in a case tried by Parke, B. (*Reg.* v. *Spriggs*, Lewes Lent Assizes, 1854), in which the prisoner was charged, upon his own statement, with having caused the death of his wife by discharging at her a loaded gun. When seen shortly after by the medical witness, deceased was quite dead. There was a 'jagged' wound upon her forehead, about an inch above the right eyebrow. The witness described it as a wound which, from its appearance, might have been produced by any blunt instrument, or by a gun fired from a short distance! On further examination it was found that the back part of the head had been driven in (?), and it appeared as though the shot had passed completely through the head and brain, passing out behind in a direction slanting downwards, the wound behind being three inches lower than that in front. He did not see any shot, nor did he open the head to endeavour to find any; but a portion of the skull and hair had been driven into the wound. The learned judge properly suggested that the brain should have been examined, as some shot might have remained there, and this would have shown exactly how the mortal injury had been produced. The medical witness was strongly pressed to say whether he was certain the injury had been caused by shot and not by a bullet. He said he was certain it was by shot, as he had had much experience of bullet-wounds in Ireland! Fortunately, there was good evidence to show that one barrel only of the prisoner's gun had been discharged, and the undischarged barrel was found loaded with shot. The prisoner was convicted. There appears to have been no mark of burning or singeing of the hair or dress in this case, or the witness would not have suggested that the wound might have been occasioned by a blunt instrument. Considering that there were two penetrating wounds on opposite sides of the head, this was a singular part of the evidence. It was clear that there was one great central wound (the entrance-wound), which although described as 'jagged,' appeared difficult to be accounted for, as no shot were scattered, or could be found in the skin. Yet this single wound was obviously caused by small-shot. In all similar cases, it would be proper to examine the track of a wound throughout. According to Lachèse's experiments, it is probable that the piece was in this case discharged within twelve to eighteen inches from the surface of the skin.

A discharge of small-shot, in contact with the skin or close to it, generally produces, not a round opening, but a severe lacerated wound. In the case of a gentleman of the Scotch bar, an accidental gunshot wound in the leg occurred under the following circumstances:—He had, during a sporting excursion, lain down on the grass and fallen asleep, the muzzle of his gun being close to the back of the calf of his left leg, and pointing in a slanting direction downwards. By some accident the gun went off, and the shot produced a complete laceration of the whole of the fleshy part of the leg, with no appearance of a round perforation. As might be expected from the closeness of the discharge, the leg of his trousers was much burnt as well as cut and torn. Although, according to Dr. Lachèse's experiments, a round opening may be pro-

duced by small-shot when the piece is fired at the distance of a foot from the body, the above case clearly proves that the shot may be scattered, and an extensively lacerated wound caused, when the muzzle is close to the skin, and the piece is not discharged point-blank. The scattering of the shot, however, in such a case, could not lead to the inference that the discharge had taken place from a distance, because the skin and dress would always present distinct marks of burning. When a piece is fired near, the shot may be carried into the wound without scattering, and it may be found lying like a solid mass in the wound. This was proved to have been the case in *Reg.* v. *Evans* (Swansea Lent Assizes, 1869). Dr. Mackintosh, of Downham, communicated to me a similar case which occurred in 1869. A gentleman was accidentally shot by the discharge of his gun from behind. The entire shot were found lodged, as in a purse, in the muscles behind the thigh-bone.

The course taken by small-shot, when discharged at short distances, may indicate the direction in which the discharge took place, and thus aid in the identification of the assailant. In *Reg.* v. *Marris* (Lincoln Lent Assizes, 1870), it was a question whether the wound indicated the direction in which the gun was fired. The deceased was shot while passing along a public path. If the prisoner were guilty, he must have fired the gun from a window more than twelve feet above the ground. According to the medical evidence, the shot must have been fired downwards. It had blown away the upper lip, the teeth, and lower jaw. The prisoner was convicted.

Small-shot is rarely observed to traverse the body entirely unless discharged so near as to make a clean round opening; but a single pellet reaching the body may destroy life. There may be no exit-aperture, or it may be smaller than that of entrance. Two cases have already been mentioned: one in which a young man was killed by a single pellet wounding the fifth intercostal artery; the other, in which a girl was killed by a pellet traversing the orbitar plate and wounding the brain. Such minute wounds might be easily overlooked in the examination of a dead body. Small-shot, even when wounding only the skin of the back superficially, has been known to cause death by tetanus. In the post-mortem examination of the body of a person who has been killed by a discharge of small-shot, the pellets do not always present a rounded appearance. By the force of the discharge, especially when near to the body, or when any bony surface has been struck, the spherical form of the shot may be almost entirely lost. In *Reg.* v. *Evans* (Swansea Lent Assizes, 1869), it was attempted to connect the prisoner with an act of murder by the appearance of the shot removed from the dead body. Some slips of lead, with small cut portions of the metal of a rough cubic form, were found in prisoner's possession. A portion of the shot removed from the body of deceased, who was found dead, had a similar cubical form. They consisted only of lead, but it was impossible to say that the lead was the same as that found in the possession of the prisoner. The evidence failed to connect the prisoner with the act. Cut lead, in the form of slugs, may be mixed with shot, and it appeared to be so in this case. In all manufactured shot there is arsenic. If this is found, it would show that ordinary shot had been used.

When in an act of suicide a pistol is discharged close to the chest, the amount of injury done cannot be measured by the size of the bullet. Dr. J. D. Moore, of Lancaster, communicated to me a case of suicide (July 1869), in which a man discharged a pistol pressed closely to his chest, loaded with a bullet only three-eighths of an inch in diameter. The whole of the clothes were torn through, and portions of them, with parts of the ribs, were carried deeply into the chest. The opening in the chest was circular, and three inches in diameter. The margin was burnt and ragged. The heart was intact, but the

1845.) The situation in this instance negatived the supposition of suicide. Suicidal gunshot wounds are seldom situated at the back of the body; therefore the determination of the point of entrance, if the ball has traversed, is of some importance. The direction of these wounds is probably of less moment than their situation, because the projectile is liable to be deflected in the body. In a duel which occurred in Paris, in 1827, one of the parties, a tall man, was killed by a ball which was found to have entered below the right shoulder, and to have taken a direction downwards. In consequence of this, it was thought that he had been shot unfairly by his antagonist, who was short in stature. Breschet and others explained the suspicious course of the wound by assuming that the ball had struck the under part of the clavicle, and had thence probably been deflected downwards. This question excited considerable interest at the trial of a Dr. *Smith* for the murder of a *William Macdonald*, at St. Fergus, in Scotland (High Court of Justiciary, Edinburgh, April 1854). It appeared from the evidence that the deceased was found dead in a field belonging to the prisoner, on the morning of Sunday the 20th November 1853. The body, according to the testimony of eyewitnesses, was lying at full length on its left side in a ditch. The left arm was partly beneath, and the right partly across the body. There was a blackened wound or hole in the cheek, and a little blood on the cheek. A pistol was lying on the ground, according to one witness, about four feet from the head of the deceased. The time at which the deceased died was fixed with tolerable precision at twenty-five minutes before eight o'clock on the evening of the 19th November; and although the prisoner was not seen near the spot, there was evidence that he had made an appointment to meet the deceased that evening, and the testimony of many witnesses showed that he had had an opportunity of being on the spot at the time when the discharge of a pistol had been heard. The defence was, that this was an act of suicide. The pistol could not be identified as belonging to the prisoner; and one witness for the defence positively swore that, six years before, he had sold to the deceased a pistol resembling that found near his body! Upon this statement, and upon the failure of the medical evidence to throw any light upon the important question of homicide or suicide, the prisoner was discharged on a verdict of Not Proven. ('Med. Times and Gazette,' April 22 and May 20, 1854.)

It was proved by the two medical witnesses who gave evidence at this trial, that deceased had died from a pistol-shot, the bullet having penetrated the brain. From the characters of the wound, one thought that the muzzle of the pistol, when discharged, must have been within from three to twelve inches of the face. He admitted that, as an act of suicide, the body might have assumed the position in which it was found, but that the probabilities were against it. The other witnesses thought that the pistol, when discharged, might have been twelve or thirteen inches from the face; and although a person standing could, in his opinion, have made the wound that appeared on the cheek, yet a suicide would probably have made more sure of his aim, by selecting another position. The only information regarding the wound was, that it was in the right cheek, below the malar prominence; that the opening was blackened, and the nose scorched with gunpowder. It appears that the medical witness did not see the body until after the lapse of *two days!* It had in fact been removed from the spot, washed, dressed in grave-clothes, and put into a coffin, before they saw it. (Letter by Dr. Gordon, 'Med. Times and Gaz.' May 20, 1854, p. 525.) Thus the marks of gunpowder on one of the hands, generally found in suicide by pistols, were not seen here; and the removal of the body from the spot placed the medical men in a difficulty, since they could base their opinions only on the statements of ignorant witnesses. There were marks of blood on the ground, but these, it was suggested, might have been accidentally caused during the re-

moval of the body. The situation of the wound, *i.e.* below the malar prominence in the cheek, is rather unusual for an act of suicide, but it was such as a murderer walking by the side of the deceased could have easily selected. The distance at which the pistol was held appears to have been greater than we usually find in cases of suicide; for had it been close, as it usually is in suicide, there would have been marks of extensive burning and laceration of the soft parts about the wound. The position of the pistol with respect to the dead body, as described by the witnesses who found it, is inconsistent with the supposition that deceased had thus fallen accidentally after having himself discharged the pistol. There was no motive for suicide, and no reason why, had suicide been contemplated, the deceased should have selected the prisoner's field for perpetrating the act. Deceased had been seen transacting business within half an hour of the time at which he must have died; and it was stated by his friends that they had never seen him with a gun or pistol in his possession, and had never known him to use fire-arms. Every fact, medical or moral, tended to prove that this was an act of homicide and not of suicide: further, there was no mark of struggling or scuffling, and no robbery had been perpetrated. The motive suggested by the prosecution against the prisoner, was based on the fact that he had recently effected insurances to the amount of about two thousand pounds in three different offices, upon the life of the deceased, without having any pecuniary interest to justify the act. The insurances were for short periods, and it appears to be the practice in the Scotch offices that the policy is not rendered void by the act of suicide. It is important to state, as a supposed motive for the act, that the risk connected with the largest insurance (for one thousand pounds) commenced on the 24th November 1852, and terminated on the 24th November 1853. Only one premium to the amount of about eleven pounds had been paid, and this payment was proved to have been made by the prisoner Smith. The deceased was found dead on the 20th November, *i.e.* only four days before the date at which the policy of insurance upon his life would have lapsed. The accused had thus the motive, means, and opportunity of committing the crime, but there were no circumstances which could directly connect him with it. The early interference with the body, and the neglect to call for a medical investigation, probably led to the obliteration of parts of the evidence which would have clearly satisfied the jury that this could not have been an act of suicide.

Accidental gunshot wounds bear the characters of near wounds: they may touch vital parts, but, if the body has not been disturbed, the presence or absence of design in the infliction of a wound is commonly made apparent by the relative position of the body and the weapon. They frequently arise from persons drawing the charges of guns or pistols with the muzzles pointed towards them, and they are then situated in front: at other times they are produced by persons pulling towards them through a hedge, or dragging after them, a loaded gun. In the latter case the wound is behind, and it may strongly resemble a homicidal wound, although the circumstances under which the body is found generally suffice to explain the matter. (See 'Ann. d'Hyg.' 1860, 1, 443.) In the following case of attempted suicide, the characters of the wound somewhat resembled those which are commonly imputed to homicide. In March 1844, a man was brought to Guy's Hospital, with a large ragged gunshot wound on the right side of the head, behind the angle of the jaw, and between it and the ear. No slugs or bullets could be found; the direction was from behind forwards and from above downwards. According to this man's statement, the pistol missed fire three times, but he succeeded in discharging it into his mouth at the fourth attempt. He lost a large quantity of blood, but after some time he walked to a table at the distance of five yards, reloaded the pistol, and discharged it at the back of his head in the situation described. Thus, then, there

The margin of the wound was jagged, had a bluish-black or mottled appearance, and the edges of one of the ribs was laid bare. The paper pellet took a course downwards, as a result of a deflection of the projectile by the rib. A quantity of brown paper was removed from the wound, and the boy ultimately recovered. The question which Dr. Mackintosh proposed to consider was whether paper-wadding could really produce such a wound as was here found, when the gun was fired from a distance of *two or three yards.* Without going into details, it may be stated, that when the gun was charged with a small quantity of powder and brown-paper wadding, there was indentation, but no penetration at a distance of two yards. With one-third more powder and a brown-paper pellet closely compressed, there was penetration through the boy's jacket to an inch and a half beyond. These facts bear out the conclusion already given, and confirmed the boy's account of the distance from which the gun was fired at him by the prisoner. Dr. Swift had inferred from his experiments that a penetrating wound from wadding was not produced unless the piece was discharged within a distance of six inches; but Dr. Mackintosh's results clearly show that this must depend on the quantity of powder used and the loose or condensed nature of the substance employed as a projectile.

Identity from the flash of gunpowder.—Among the singular questions which have arisen out of this subject is the following:—Whether the person who fires a gun or pistol at another during a dark night can be identified by means of the light produced in the discharge? This question was first referred to the class of Physical Sciences in France, in 1809, and they answered it in the negative. A case tending to show that their decision was erroneous was subsequently reported by Fodéré. A woman positively swore that she saw the face of a person, who fired at another during the night, surrounded by a kind of glory, and that she was thereby enabled to identify the prisoner. This statement was confirmed by the deposition of the wounded party. Desgranges, of Lyons, performed many experiments on this subject, and he concluded that on a dark night, and away from every source of light, the person who fired the gun might be identified within a moderate distance. If the flash was very strong, the smoke very dense, and the distance great, the person firing the piece could not be identified. The question was raised in this country, in the case of *Reg.* v. *White*, at the Croydon Autumn Assizes, 1839. A gentleman was shot at while driving home in his gig during a dark night; he was wounded in the elbow. When he observed the flash of the gun, he saw that the piece was levelled towards him, and the light of the flash enabled him to recognize at once the features of the accused. In cross-examination he said he was quite sure he could see the prisoner, and that he was not mistaken as to his identity. The accused was skilfully defended, and he was acquitted. Evidence of this kind has, however, been received in an English Court of Law. A similar case was tried at the Lewes Lent Assizes, 1862 (*Reg.* v. *Stapley*). The prisoner shot at the prosecutor, a gamekeeper, on a dark evening in December, and the latter swore that he distinctly saw the prisoner by the flash of the gun, and could identify him by the light on his features. His evidence was corroborated by three other witnesses, who saw him not far from the spot, and by one who saw him in the act of running away. He was convicted. A case is quoted by Paris and Fonblanque (*Rex* v. *Haines*), in which some police-officers were shot at by a highwayman during a dark night. One of the officers stated that he could distinctly see, from the flash of the pistol, that the robber rode a dark-brown horse of a remarkable shape in the head and shoulders, and that he had since identified the horse at a stable in London. He also perceived, by the same flash of light, that the person had on a rough brown great-coat. This evidence was considered to be satisfactory.

From the information which I have been able to collect on this point, it

appears to me there can be no doubt that an assailant may be thus occasionally identified. It is widely different, however, in respect to the following case referred to by Müller, in his 'Physiology,' namely, where a man declared that he recognized a robber through the light produced by a blow on his eye in the dark! As Müller observes, this is a clear impossibility, because the flashes thus perceived are unattended with the emission of light, and therefore can never be visible to any other person than the subject of them, and it is not possible that they can ever make other objects visible. (For some remarks on this subject by Dr. Schilbach, see Henke's 'Zeitschrift der S. A.' 1842, 1, 197.) Dr. Krügelstein has opposed the inference deduced by Müller, and has supported his views by cases, which, however, do not appear to me to be satisfactory. (Henke's 'Zeitschrift der S. A.' 1845, 3, 172.)

For a description of the chemical examination of fire-arms, to determine whether they have been recently discharged or not, the reader is referred to p. 515.

CHAPTER 50.

DEATH FROM BURNS AND SCALDS—SYMPTOMS—STUPOR—CAUSE OF DEATH—POST-MORTEM APPEARANCES—BURNS ON THE DEAD BODY—ACCIDENT HOMICIDE OR SUICIDE—WOUNDS CAUSED BY FIRE—SCALDING—BURNS BY CORROSIVE LIQUIDS.

Burns and scalds.—A *burn* is an injury produced by the application of a heated substance to the surface of the body; while a *scald* results from the application of a liquid at or near its boiling point, under the same circumstances. There seems to be no real distinction between a burn and a scald as to the effects produced on the body: the injury resulting from boiling mercury or melted lead might take either appellation. Nevertheless, as a matter of medical evidence, it may be important to state whether the injury found on a body was caused by such a liquid as boiling water, or by a heated solid. If the former, the injury might be ascribed to accident; if the latter, to criminal design. A scald produced by boiling water would be indicated by a sodden state of the skin and flesh, but there would be no destruction of substance. In a burn by a heated solid, the parts may be more or less destroyed, or even charred; the cuticle may be found blackened, dry, almost of a horny consistency, and presenting a shrivelled appearance. This distinction would only apply to scalds from water. A scald from melted lead could not be distinguished from a burn produced by a solid heated to the same temperature. Some of the oils boil at 500°, and they produce by contact with the skin burns as severe as those caused by melted metals. Burns from flame such as that of gas are indicated by extensive scorching of the skin, while burns from gunpowder are known not only by the scorching, but by the small particles of unburnt carbon which are imbedded in the skin.

Action of melted metals.—A singular case, in which an attempt on life was made by pouring a melted metal into the ear, occurred to M. Boys de Loury. The mother of an idiot, aged twenty-five, wishing to get rid of him, adopted the plan of pouring melted pewter into his right ear while he was lying asleep. Great pain and violent inflammation followed, but the young man recovered. The mother then alleged that he had himself poured the melted metal into his ear. At a judicial investigation, M. Boys de Loury was required to say whether such an act was likely to occasion death, and, if so, how it happened that the party had in this instance recovered. The alloy was formed of seven parts

of tin and three of lead, and the melting point of such an alloy would be about 340°. M. de Loury stated that such an act might lead to death, by causing inflammation and disease of the bones of the internal ear extending to the brain. The recovery of the youth was owing to the mischief which followed having been comparatively slight. In performing some experiments on the dead body, he found that it was difficult to fill the ear-passage with such an alloy, in consequence of the sudden expansion of the air caused by the high temperature. ('Ann. d'Hyg.' 1847, 2, 424.)

Various degrees of burns.—Dupuytren has divided burns into six degrees, which are commonly recognized by medical jurists :—

1. The heat produces a simple inflammation of the skin without vesication. The skin is red, but the redness disappears on pressure: there is slight and superficial swelling, with severe pain, relieved by the contact of cold substances. The inflammation subsides after a few hours, and the skin resumes its natural condition; or it may continue for several days, and the cuticle then peels off.

2. There is a severe inflammation of the skin, and the cuticle is raised into blisters containing a yellow-coloured serum. This kind of injury is generally the result of the action of boiling liquids. Some blisters are formed *immediately*; others are produced during a period of twenty-four hours, and those which are already formed become enlarged. Suppuration takes place if the cuticle is removed, and the person survives for a period sufficiently long. As the cutis or true skin is not destroyed by this degree of burn, there is no mark or cicatrix left on healing, to indicate its past existence.

3. The superficial part of the cutis is destroyed. The burn appears in the form of yellow or brown patches, insensible when gently touched, but giving pain when strongly pressed. An inflammatory redness, accompanied by vesication or blistering, is perceived in the healthy portion of skin around the eschars. A white and shining cicatrix, without contraction of parts, remains after healing. This degree of injury is commonly observed in burns from gunpowder, and the part which was the seat of the burn is frequently stained black, when the particles of gunpowder have not been removed soon after the accident.

4. The skin is destroyed as far as the cellular tissue beneath. There are firm and thick eschars (dead portions of skin), which are quite insensible. If the burn has arisen from a boiling liquid, the eschars are soft and of a yellowish colour; if from a red-hot solid, they are firm, hard, and of a brown colour—sometimes black. The skin appears shrivelled and puckered towards the eschar, which is depressed below the surface. The surrounding skin presents a high degree of inflammation, and vesications appear. From the fourth to the sixth day the eschar falls off, leaving an ulcerated surface which heals slowly, and is always indicated by a cicatrix.

5. In the fifth degree, the whole of the layers of the skin, the cellular membrane, and a portion of the muscles beneath, are converted into a general eschar. The appearances are similar to those of the fourth degree, but in a more aggravated form.

6. The burnt part is completely charred. If the person survives, violent inflammation is set up in the subjacent tissues and organs.

Neither a burn nor a scald appears to be considered as a *wound* in law; but in the statute on wounding they are included among bodily injuries dangerous to life. Burns and scalds may be regarded as dangerous in proportion to the extent of surface (of skin) which they cover, as well as the depth to which they extend. The extent of skin involved in a superficial burn, as a result of exposure to flame, is of greater importance than the entire destruction of a small part of the body through an intensely heated solid. When the burn is exten-

sive, death may ensue either from the intensity of the pain produced, or from a sympathetic shock to the nervous system. Death takes place rapidly from burns in children and nervous females; but in adults and old persons there is a better chance of recovery. From a statistical report published in 1863 by the Registrar-General, it appears that in fourteen years (1848–61) 39,927 persons died from the effects of burns and scalds. Of this number 15,621 were children under five years of age. In 1858 the deaths registered in London from burns and scalds amounted to 309, and in 1867 to 302. In the ten years 1858–67, 3,258 lives were destroyed in London by these causes. In England and Wales in the eighteen years 1848–65, 51,160 persons lost their lives by burns and scalds, 25,345 males and 25,815 females, making the annual loss of life from these causes 2,842. A large proportion of the deaths occurred among young children.

Symptoms. Stupor from burns.—In some instances, especially in children, stupor and insensibility have supervened, owing to the sympathy of the skin with the brain; and these symptoms have been followed by coma and death. If, under these circumstances, opium has been given to the patient as a sedative, the stupor resulting from a burn may be attributed to the effects of the drug; and should the person die, the practitioner may find himself involved in a charge of malapraxis. It may be alleged, as in the following case, which occurred to Mr. Abernethy, that the person was poisoned by opium. A medical man was charged with the manslaughter of a child by giving to it an overdose of opium, while it was labouring under the effects of a severe scald. Mr. Abernethy stated, in his evidence, which was given in favour of the practitioner, that he thought the exhibition of opium very proper: that the quantity given, eight drops of tincture of opium immediately after the accident, and ten drops two hours afterwards, was not an overdose for a child (the age is not stated). The circumstance of the child continuing to sleep until it died, after the exhibition of the opium, was, in his judgment, no proof that it had been poisoned. This sleep was nothing more than the torpor into which it had been plunged by the accident. The surgeon was acquitted. Notwithstanding the very favourable opinion expressed of this plan of treatment, it would be advisable to avoid the use of opium on these occasions in respect to infants and children. Life is readily destroyed in young subjects by the smallest doses of this drug (see p. 351): and there are no satisfactory means of distinguishing the comatose symptoms produced by a burn or a scald from those produced by an overdose of opium.

Cause of death.—Of the cause of death in persons exposed to fire but little need be said. In large conflagrations persons are frequently simply suffocated, from the want of proper air or the respiration of the products of combustion—carbonic acid or carbonic oxide. The former darkens the blood; the latter renders it lighter in colour. In other cases, where a large volume of flame suddenly falls upon the body and the person is still able to breathe, the fatal effect may be due to shock; *i.e.* a sudden and violent impression on the nervous system. A person may recover from the first effects of severe burns, but ultimately sink from exhaustion or from a sudden attack of tetanus. ('Med. Times and Gaz.' April 26, 1854, p. 406.) The causes of death from extensive burns of the skin and the appearances presented by the internal organs, have been most fully investigated and described by Dr. Mendel of Pankow, in Horn's 'Vierteljahrsschrift,' 1870, 2, 93.

As a result of burns from explosions, a person either dies speedily or he recovers. In a case tried at the Swansea Lent Assizes, 1869, it was proved that a man had sustained severe burns from an explosion of fire-damp in a coal mine. He recovered partially from the first effects, but lingered for nearly three months, when he died—according to the medical evidence, from inflammation and ulceration of the bowels. There was no other apparent cause for

this inflammation but the burns, and death was referred to the burning as the primary cause. There was no actual recovery from the time of the occurrence until death. I have been informed that, in the coal-mining districts, inflammation and ulceration of the bowels is not an unusual result of burns affecting a large surface of skin, when the person lingers for some time after the accident.

The observations made by my colleague, Dr. Wilks, confirm these views. He has found that, in reference to burns, death has been in some cases immediately due to bronchitis, pneumonia, or pleuro-pneumonia. If the patient survive but a short time, the fatal result is put down to shock; if, also, he lives for a few days and no marked appearances are found in the viscera, death is attributed to the same cause. He describes a case, in which a boy æt. 2 was scalded in the face, neck, and chest with hot water, and he died in eight days. The body was carefully examined, and no morbid changes could be found to which to attribute death (G. H. R. 1860, 6, 146.) A girl, æt. 9, died nine days after her clothes had caught fire. Twenty-four hours before death she became very restless, and subsequently all her limbs and body were stiffened as in tetanus. There were no convulsions. There were burns on the upper part of the chest and both arms, with sores granulating and suppurating. The brain appeared quite healthy, also the spinal cord. All the organs throughout the body were quite healthy (ibidem). These cases should teach caution in reference to prognosis.

Post-mortem appearances.—In examining the body of a person found burnt, all matters connected with sex and identity should be duly observed. Dr. Grünbaum has reported a case in which he was required to examine certain carbonized remains in which, in spite of the destruction of the sexual organs, he was able to determine the sex. (Horn's 'Vierteljahrsschrift,' Oct. 1864, p. 303.) The presence of a large quantity of phosphate of lime in the ashes would indicate animal remains; but the bones are never completely destroyed. They become white, and portions of them retain their form under the action of a most intense fire. When death has been caused by severe pain, no changes have been detected in the dead body; but, under other circumstances, it has been found on inspection that there were patches of redness on the bronchial mucous membrane, as well as on that of the alimentary canal. The brain has been found gorged, and the ventricles have contained an abundance of serosity. The serous liquids of the pericardium and pleura have also been in larger quantity than natural. In short, besides congestion, there is generally abundant serous effusion in one of the three great cavities, especially in the head. This arises from the sudden reflux of blood into the interior, as an effect of the local injury. (See case by Mr. Long, 'Med. Gaz.' vol. 25, p. 743; also, by Mr. Erichsen, vol. 31, p. 551.) In deaths from fires in houses the persons are usually suffocated, and there are the appearances of this kind of death (see SUFFOCATION). In a case in which a woman died on the thirteenth day from a superficial burn involving the skin of the lower part of her body, the stomach was found inflamed at its greater extremity, and the duodenum at its lower portion—the mucous folds of the intestines having a scarlet colour. The other intestines as far as the cæcum were also more or less inflamed. ('Amer. Jour. Med. Sciences,' Jan. 1861, p. 137.) If the person survives the first effects, he may die from inflammation, suppuration, gangrene, irritation, or fever, or he may be worn out and die from exhaustion. In this respect, burns of the fourth, fifth, and sixth degrees are especially dangerous to life; and it would be unsafe to give a premature opinion of the probable result, as inflammation of deep-seated viscera only appears after several days. In the cases of six children burnt to death in December 1862, Dr. Buzzard made the following observations. The eyelids were firmly closed; the limbs were contracted, and the hands clenched. The burns on the bodies of these

children were of great superficial extent, but not deep. Nearly three-fourths of the surface of the body had suffered from the effects of fire, and in all, the hands were very much burnt. In one of the bodies least injured by the fire he found the skin and covering of the chest injected with bright red blood. The lungs were much congested, and of a bright red colour. The cavities of the heart were empty. The brain was congested with red blood. He found no blood in the body presenting the usual characters of venous blood. He attributed death to the shock from sudden and extensive burns, and not to suffocation. (See 'Lancet,' 1863, 1, 60.) In a case of death from burning examined by the late Mr. Jackson of Stamford, in 1860, the lungs were congested, and the cavities of the heart were empty. No particular observation was made as to the colour of the blood. The tongue was swollen, and there were some other appearances indicative of strangulation; so that the burning had probably been resorted to in order to conceal the mode of death. There was a blister or vesication on the top of the chest, showing that when the body was burnt it retained some degree of vitality. The eyes were much suffused. The reader will find a full account of the appearances presented by the bodies of persons who have died from burns in Horn's 'Vierteljahrsschrift,' 1870, 2, 93, by Dr. Mendel of Pankow. It will be seen that the appearances vary according to the seat and extent of the burns, and the time at which they prove fatal. In protracted cases the organs of the chest and abdomen frequently present marks of inflammation and its consequences. (See also a paper by Dr. Wilks, G. H. R. 1860, No. 6. p. 146.)

The principal subject on which medical evidence is required on these occasions is in reference to the question whether, in a dead body found burnt, the burning took place during life or after death. As bodies are sometimes burnt in order to conceal other acts of violence, a careful inspection should be made to determine whether there are indications of any other kind of violence. The power to answer these questions must depend on the degree to which the action of the fire has been carried. The remains may be so charred as to render all such inquiries nugatory.

Did the burning take place before or after death?—Vesication.—The production of *vesication* or of *blisters* containing serum, is commonly regarded as an essential character of a burn which has been produced during life, but it is not a necessary or invariable effect of a burn on the living body. Vesication is especially observed in scalds, or in those cases in which the skin has been burnt by flame or by the ignition of the clothes, provided the cuticle has not been destroyed. It is not so commonly observed in burns produced by intensely heated solids. In vesication, the cuticle is raised from the true skin beneath, and is converted into one or more blisters containing serum, while the skin around is of a deep red colour. It is uncertain as to the time at which it appears; it may be produced in a *few minutes*, or sometimes not for several hours; hence death may take place before vesication occurs, and the non-discovery of this condition does not warrant the opinion that the burn could not have taken place during life. If the cuticle is removed from a vesicated part of the living body, the skin beneath will become intensely reddened; but if the cuticle is stripped off a dead body, the skin will become hard, dry, and of a horny-yellow colour; it does not acquire the intense scarlet injection which is acquired by the living skin when vesicated and exposed.

There have been conflicting opinions whether the presence of blisters (vesication) on a dead body should be received as absolute proof of burning during life. The following may be taken as a summary of the facts hitherto ascertained. Sir R. Christison had an opportunity of trying experiments on the effects of dry heat on the same body before and after death; this was in the case of a young man who had poisoned himself with opium. While he was lying in a

hopeless state of coma, four hours before death, a hot iron was held on the outside of the hip-joint; and half an hour after death, a red-hot poker was applied to three places on the inside of the arm. Vesication followed the burns in both instances; but those caused during life contained serum, and those which were formed after death, *air*. In a second experiment, a cauterizing iron produced no blisters on a leg, half an hour after amputation; but vesications containing air were formed when the iron was applied ten minutes after amputation. On the whole, Sir R. Christison thinks that a vesication containing serum indicates a burn during life, and one containing air, a burn after death. I have performed some experiments on the bodies of infants eighteen and twenty hours after death, both with boiling water and heated solids; but in no case have I observed any kind of vesication to follow at that period. The skin was shrivelled, and was partly destroyed by the heat, but there were no blisters produced. (See a paper by M. Olliver, 'Ann. d'Hyg.' 1843, 1, 383.) Under certain morbid states, blisters containing serum may be produced in the dead body, even twenty-four hours after death. M. Leuret observed that this took place in a dropsical subject, in the vicinity of which a heated brazier had been placed. The cuticle was hardened, then raised and blistered; and the blister contained an abundance of reddish-coloured serum. In repeating this experiment on other dead bodies not infiltrated, it was observed that no vesications containing serum were produced. ('Ann. d'Hyg.' 1835, 2, 387.) M. Champouillon has repeated the experiments of M. Leuret on bodies affected with general dropsy, and he finds that blisters may be produced in them at almost any period after death. Thus, they occurred when heat was applied to one recently dead, to another when in a state of cadaveric rigidity, and to a third when putrefaction had commenced. The blisters did not appear immediately,—the time which he found requisite for their production varied from two to six hours. The serum effused beneath the raised cuticle was rarely tinged with blood. ('Ann. d'Hyg.' 1846, 1, 421.) These experiments only confirm the results previously obtained by M. Leuret; they add nothing to our knowledge of the subject. The conclusion to be drawn from them is, that in the examination of *burns* on the body of a person affected with general dropsy, it is necessary to be cautious in expressing an opinion. In such cases it would not be possible, from the existence of mere vesication, to say whether the burn took place before or after death.

The late Dr. Wright, of Birmingham, has published the results of some experiments on burning after death, from which he infers that the production of a *serous* blister, or a blister containing serum, in the dead body is not dependent on the presence of serum in the cellular tissue (anasarca), but upon the amount of (latent) organic life remaining in the body. He states that he has produced a serous blister in a dead body more than a dozen times—twice within half an hour, and once within fifteen minutes after death; and in amputated limbs he has produced them in from half a minute to four minutes and a half after amputation. The only favourable opportunity which occurred to him for producing a serous blister after death, was in the case of a woman thirty years of age, who died suffocated from acute congestion of the lungs. She was slightly dropsical. *Three hours and a half* after death, when the body was quite warm and the joints were flexible, a spirit-lamp flame was applied to the lower and back part of the left leg. After the lapse of an hour, blisters had been formed, and were filled with serum of a pale straw-colour: one contained two and the other three drachms. Ten and fifteen hours after death, when the body had become cold and rigid, the flame produced only *gaseous* blisters. ('Pathological Researches on Vital and Post-mortem Burning,' 1850.) The results obtained by Dr. Liman in performing similar experiments on five dead bodies, in from one to two hours after death, are not in accordance with

those described by Dr. Wright. Liman noticed that by a spirit-flame a blister might be raised, but that it contained nothing more than vapour derived from the fluids of the skin beneath the cuticle. It soon became flat and charred, and there were no changes in the surrounding skin indicative of vital reaction. The temperature (of the bodies) varied from 78° to 98°. No experiments were performed on the bodies of persons dying or just dead. (Casper's 'Viertel-jahrsschrift,' 1863, 24, 367.) It is, therefore, exceedingly doubtful whether, except under special conditions of the body such as general dropsy, blisters containing serum can be produced by a burn on the skin of a person really dead. Dr. Christison found that when boiling water was poured upon a dead body *ten minutes* after death, the skin was simply ruffled and shrivelled; but the cuticle was not raised into a blister. The same effects were produced so long as the body retained its warmth. Accident has enabled me to describe the results within a shorter period than that above mentioned. The body of a drowned man, within a few minutes after the accident, was removed from the water and placed in a warm (hot?) bath. It was found impossible to resuscitate him, but owing to the great heat of the water portions of the cuticle came off, when the body was removed. On inspection there were several vesications *filled with bloody serum* over a considerable portion of the skin, especially of the extremities. There was no anasarca here to account for their production; and the fact of their occurrence appears to bear out the view of Dr. Wright, that the production of a *serous* blister on a dead body depends on the amount of latent organic life remaining in it. In this case the man was pulseless, and to all appearance *dead*, when placed in the hot bath; hence the effects of *hot liquids* on the living and the recently dead body, so far as the production of vesication is concerned, are proved by this case to be similar. Dr. Chambert has lately published the results of numerous experiments on the effects of burns on the living and dead body. These have been made on the bodies of persons, from the moment of death until twenty hours after dissolution, and some were performed before death. The general results of his researches are,—that vesications, or blisters, may be produced by burns both on the living and dead body; that they are produced at a lower temperature in the living than in the dead; that in the living a burn produces great capillary congestion, with the effusion of serum in the blisters, and that this serum, when heated, or treated with nitric acid, sets into a nearly solid coagulum. The blisters produced in a dead body, even a few minutes after death, contain a thin watery serum, which is only rendered opaline or milky by heat and the action of nitric acid. ('Ann. d'Hyg.' 1859, 1, 342.)

A line of redness.—In burns, especially in those produced by red-hot solids, other effects besides vesication follow. The edge of the skin immediately around the part burnt is commonly of a dead white, and close to this is a *deep red line*, gradually shaded off into the surrounding skin, which is reddened. The diffused redness is removable by pressure, and disappears with life; the red line here referred to, however, is not removable by pressure, and is persistent after death. This line of redness is not always met with in severe burns, and when a person survives one or two days, its production appears to depend upon a power of reaction in the system. Thus, then, its absence furnishes no proof of the burn having been produced after death, for it is not a necessary accompaniment of a burn during life. Sir R. Christison has endeavoured to determine by experiment whether this line of redness could be produced by applying a heated iron to a dead body. He found that when the person had been dead only *ten minutes*, no such effect was produced. In repeating his experiments on bodies many hours after death, I have found that no line of redness ever presented itself; so that its discovery in a dead body burnt, would appear to indicate either that the burning took place during life,

or within a few minutes after death—most probably the former. M. Champouillon takes exception to the inference derivable from these experiments. He says that he has caused the production of a line of redness by the application of heat to a dead body, and that it is a uniform accompaniment of the formation of blisters in the dead. He admits that it is in this case a mere capillary infiltration of blood, quite superficial, and surrounding the margin of the blister; while in the red line produced during life the tissues of the skin are deeply injected, and this line is evidently the result of vital reaction. (See 'Ann. d'Hyg.' vol. 1, p. 442.) It would appear that he has only remarked this condition in dead dropsical bodies, in which vesications had been produced, and it is obvious from his description that he is referring to a slight congestion of the vessels, occasioned probably by the stagnation of the fluid portion of the blood in the superficial capillaries. It is altogether distinct from the line of redness described by Christison as a frequent consequence of severe burns. In the case of *Mr. Westwood* (June 1839), the fact of certain burns on the body having been produced during life was determined by Mr. French, from an observation of this sign. The deceased was found dead, with his skull extensively fractured, his throat cut, and his body burnt in various places. Mr. French, who gave evidence on this occasion, remarked that the burns were surrounded by a line of redness—that they were probably produced about the same time as the other injuries, but certainly while there was some vital action in the system. When, however, vesication and a line of redness are absent, we have no medical data on which to found an opinion whether the burn was caused before or after death. Dr. Wright considered that in a low state of vitality a line of redness might not be produced by a severe burn on the living body, and that more certain reliance might be placed on the red marks found beneath the blisters and crusts of vital burns. These latter were well marked when he found the line of redness itself indistinct. (Op. cit. p. 25.) The recent researches of Dr. Chambert confirm this view. In a burn on a living person, if the skin has not been entirely charred and destroyed, the cutis will present a dotted or pointed redness, these dots or points corresponding to the sudiparous (perspiratory) and hair-follicles. After complete death, the burn does not produce any such effect; the cutis is of a dead-white on its surface and in its substance. In one experiment performed ten minutes after death, there was no redness of the skin, either beneath the blisters or in the surrounding parts. ('Ann. d'Hyg.' 1859, 1, 368.) This reddened or congested state of the bare skin is more constant than any other appearance, and forms at present the best criterion of the infliction of a burn on the living body. The medico-legal facts connected with burns on the living and the dead, underwent a minute scrutiny in a remarkable case of alleged matricide at Bridgenorth. (*Reg.* v. *Newton*, Shrewsbury Lent and Summer Assizes, 1849.)

In March 1848, I was consulted by Mr. C. L. Prince, of Uckfield, on a case of some interest in reference to the medical proofs of burns produced during life. Two persons were charged with the murder of a new-born child, which had been secretly buried and only exhumed for inspection ten days after death. Independently of an incised wound on the arm, the edges of which were everted and retracted like a wound produced on the living body, the right leg presented the marks of burning. The cuticle was entirely destroyed over the greater part of the limb: the surface beneath had an intensely scarlet colour and was much injected. There was a red line of inflammation around its edge, particularly in the upper portion, and at the lower part of the scrotum there was a large vesicle filled with serum. From this condition of the parts, Mr. Prince very properly inferred that the child must have been living when these burns were inflicted. The lungs merely indicated that respiration had been

imperfectly performed. It turned out subsequently, by the confession of the mother, that the child had been born alive, and that its body had been deliberately burnt by one of the accused parties. The child probably did not survive its birth a quarter of an hour: a proof that the marks indicative of a vital burn do not require a long period for their production.

When *several burns* are found on a dead body, it may be a question whether they were all produced at the same time. This is a point which can be determined only by observing whether any of them present signs of gangrenous separation, of suppuration, granulation, or other changes that take place in a living body after accidents of this kind. The witness may be asked, how long did the deceased survive the burn? A person may die in a few minutes or live some hours after receiving a most extensive burn; and yet there will be no change in the part burnt, to indicate when death actually took place. There may have been no time for inflammation or its consequences to become established. Suppuration generally follows vesication, and in severe cases it may occur on the second or third day; but often not until a later period. In regard to gangrene, this takes place when the vitality of a part burned is destroyed. The time of its occurrence is uncertain, but it sometimes very speedily follows the accident.

After a murder has been perpetrated, it is not uncommon for a criminal to attempt to dispose of the body by burning it. This occurred in the case of Mr. Paas (*Rex* v. *Cook*), likewise in the case of *Reg.* v. *Good*, and in another case at Leeds (Jan. 1843), where a mutilated body was found floating in a river with marks of burning about it. In general, the body is not burnt until all signs of life have disappeared; we shall therefore meet, in such cases, with nothing but the charring of dead flesh, so that no difficulty can exist in forming an opinion. When the burning is partial, and has probably taken place from a wilful ignition of the clothes, at or about the time of death, some caution is required in expressing an opinion, since marks of vesication and a line of redness are not always present in burns during life. It is by no means unusual, however, to find it stated in evidence that blisters are a constant accompaniment of a burn in the living body! In *Reg.* v. *Taylor* (York Lent Assizes, 1842), the deceased was found dead with marks of strangulation on her neck, and her clothes were much burnt from her waist to the knees. She was lying across the hearth; the body was burnt as well as the upper and lower limbs and the neck. In the opinion of the medical witness, the burn on the neck could not have been produced by fire extending from the other parts of the body. In cross-examination he stated that the burns must have occurred after death: they could not have taken place before, nor at the time of death, because there was no vesication, and he had never seen a burn on a living person which was not followed by blistering! The prisoner was convicted, his counsel having failed to prove or render it probable that death was caused, as alleged, by accidental burning. The reader will find some remarks on the burning of the living and dead body, in the report of the trial of Dr. Webster for the murder of Dr. Parkman. (See Report by Dr. Stone, Boston, 1850.)

Accident, homicide, or suicide.—It is rare that murder is perpetrated by burning: the dead body is either burnt for the purpose of entirely destroying it, or the clothes are fired soon after a person has been killed, in order to conceal wounds or other violent means of death, and to make it appear as if the deceased had been accidentally destroyed by fire. Death by burning is either the result of accident or homicide, most commonly the former, but medical evidence may give rise to a suspicion of murder, under two conditions:—1. When it is evident that several parts of the body have been fired at the same time, and the burns are such as not readily to be explained by the same accident, or by an accidental ignition of the clothes. 2. When there are marks

of homicidal violence on the body; but these marks, if we except fractures of the bones, may be easily effaced when the burn is extensive. *Accidental* deaths from this cause are very frequent among women and children. Out of 4,761 violent deaths in 1838–9, in the metropolis and the mining districts, there were 962 from burning, and 201 from scalding. In investigating a suspicious case, we must remember that the fact of a dead body not being found near a fire or any substance capable of causing ignition, does not justify an imputation of murder; since the deceased, unless disabled by intoxication, infirmity, or disease, has the power of running away from the fire after an accident, and may be found dead at a distance, without having been seen by any person. Homicidal burning cannot be established by medical evidence, so much as by that which is presumptive or circumstantial; but there are many medical questions which arise out of the circumstances under which a dead body is found burnt. Among reported cases, the two following may serve to illustrate the difficulties attending such investigations.

The first is that of a man of the name of *Gilchrist*, who was tried at Glasgow, for the murder of his wife. The prisoner and the deceased, according to the evidence, led a somewhat rambling, dissipated life. On the evening of the alleged murder, the persons who lived on the floor above them stated that they heard a noise like that of two persons struggling, and afterwards a moaning as of one choking or bleeding to death. A smell of fire now became perceptible in the house, which was soon filled with smoke. The witnesses being alarmed, went down to the prisoner's apartment, and demanded admission. After some delay he admitted them, and in doing so appeared to them to have come out of an inner room, where he said he had been sleeping. On letting them in, he stumbled over the body of his wife, who lay in the outer apartment quite dead, kneeling before a chair, and very much burnt. The prisoner was accused of having murdered her, and then burnt the body in order to conceal the manner of death. In his defence, he alleged that he had gone to bed tired, and that he knew nothing of what had happened to his wife until awoke by his neighbours. He presumed that her clothes had caught fire while she was intoxicated, and that she was thus accidentally burnt. The medical witnesses who examined the body reported that they found it so much burnt that they could give no opinion of the cause of death. The prisoner was condemned and executed, the general evidence being against him, although the precise manner of his wife's death, as Dr. Duncan observes, was not proved even presumptively.

In the second case, which occurred at Leith, Dr. Duncan was the chief medical witness. The general evidence was similar to that adduced in the case of *Gilchrist*, but stronger against the prisoner. It appears that he and his wife lived on bad terms. On the night of the alleged murder the prisoner was in bed, when his wife returned home with a lighted candle and some whisky, which she had procured at a neighbour's. Some time after, a struggling was heard in the apartment, and when this had subsided a smell of fire was perceived to issue from it. The neighbours now endeavoured to obtain admission by knocking at the prisoner's door, but he either could not or would not hear them. At last a man forced his way in, by breaking the window of the outer room. On entering, he found the room full of smoke, and something burning in a corner, over which he instantly threw a pitcher of water: this proved to be the body of the deceased. Several persons now entered the inner room, where they found the prisoner either asleep or feigning to be so. On being roused, and told that his wife was dead, he expressed neither surprise nor sorrow; but coolly demanded by what authority his neighbours had broken into his house, and threatened to send for a constable. On an examination of the body, some parts were found completely carbonized by

the action of the fire. On the face and extremities, however, the fire had not acted with such violence, and on these parts were found marks of vital reaction, indicating that the burning had taken place during life. Some spots were merely red and inflamed, others scorched to a hard transparent crust, but surrounded by a distinct redness: there were also many vesications filled with serum. From these appearances, the witnesses gave it as their opinion that the deceased had been burnt to death. The jury, in this case, returned a verdict of 'not proven,' considering probably that the deceased might have been accidentally burnt. Dr. Duncan remarks, in regard to these two cases, that the action of the fire was extremely violent and destructive, compared with the small quantity of combustible matter consumed; but by what standard this was measured we have no explanation. As the combustible material was reduced to ashes, and the time occupied in the burning was not known, such an opinion could be little more than a conjecture. In both, the burns must have been produced by the ignition of the clothes alone, since there was no trace of burning of the house or furniture in either. In the second case the deceased was found on the hearth with part of her clothes unburnt, and a chair from which she had fallen quite entire. She was dead when the neighbours entered, and the body was discovered in the dark by the red light issuing from it. An important question was raised on the second trial, in reference to the opinion of the deceased having been burnt to death, namely, whether the redness and blisters, remarked on the edges of the scorched parts, might not have arisen immediately after strangling or some other cause of death than burning, during the period when a lingering vitality remains in the body, and when undoubtedly certain phenomena of a vital nature are frequently observed. The medical witnesses felt themselves unable to answer the question decisively, but they stated that they did not consider it at all probable that blisters could be produced on the body even immediately after death. ('Med. Gaz.' vol. 8, p. 170. See case by M. Leuret, 'Ann. d'Hyg.' 1835, 2, 370.) In these two cases there can be no doubt that the fire had been applied to the clothing either wilfully or accidentally.

Suicide by burning rarely presents itself for the consideration of a medical jurist. A case of this kind occurred in the gaol of Newgate, in December 1871. One of the prisoners was found in his cell with his clothes and part of the bed-clothes much burnt, and with some severe burns on his body. The gas-light in the cell was so placed that no accident would account for the fire; but all the facts concurred to show that the man had done the act deliberately. He gave no alarm, but a moaning was heard in his cell, and this caused the warder to enter and make the discovery in time to save him.

Amongst the questions which arise in reference to a body found dead from burns is this—Whether the burns have been caused by gas, by inflammable vapours, such as petroleum, or by gunpowder. Petroleum is at once indicated by the peculiar and powerful odour, and sooty blackening of the parts. In *Reg.* v. *Gaitskell* (Carlisle Spring Ass. 1872) prisoner was convicted of manslaughter under the following circumstances. He poured a quantity of petroleum over the clothes of the deceased, and by accident the vapour caught fire, and the burns produced caused the man's death on the following day. Burns from the flame of gunpowder are generally characterized by blackening of the skin, and the introduction of some of the grains into the substance of the skin. In the Morfa colliery explosion, March 1870, it was of some importance to determine whether gunpowder or fire-damp had caused the deaths of some colliers. There was a little difficulty in the case because explosions from gas in mines generally causes a blackening of the skin from the coal-dust. The large volume of flame both in gas and gunpowder explosions causes extensive and fatal burns.

Wounds caused by fire.—On the discovery of wounds on a body which has been exposed to fire, it is necessary they should be closely examined, in order that a witness may be enabled to say whether they have been caused by cutting or other instruments *before* death by burning, or whether they are not simple mechanical results of the effects of fire on the skin. Mr. Curling communicated to me a case which will show the necessity for this inquiry. A boy, two years of age, was brought to the London Hospital, November 11th, 1840, so severely burnt on the face, neck, abdomen, and limbs, that he survived the accident only three-quarters of an hour. It appeared that the stepmother, who had charge of the child, left him at home locked up in a room where there was a fire, while she went out. Some of the neighbours shortly afterwards hearing screams proceeding from the room, broke open the door, and discovered the child enveloped in flames, and its clothes on fire. The flames were immediately extinguished, and the boy was brought to the hospital. A suspicion of ill-treatment having been excited by the appearance of wounds about the knees, which were observed as soon as the child was admitted, and by the reported neglect and ill-usage of the child by the stepmother, the coroner directed an inspection to be made. The body was plump and well-formed. The skin in the burnt parts was deprived of cuticle, and converted into a deep yellowish or blackish dry mass, which was very tense, hard, and easily torn. There were gaping wounds on both knees. On the right side, a fissure in the skin commenced about the middle of the thigh, and proceeded for two inches and three-quarters to the inside of the patella or knee-pan, where it became somewhat jagged, and making a sudden turn inwards, passed to the extent of two inches towards the back of the joint. A transverse laceration of the skin, three-quarters of an inch in length, was observed on the front of the left thigh a little above the left knee; and another which was also transverse and measured an inch and a half, was situated below, on the inner side of the joint. These fissures in the charred skin were all about three lines in width and two in depth, and exposed the fatty tissue beneath, which was white, and free from any effusion of blood. The edges of these fissures were not uneven, but they did not present the clean and smooth appearance usually observed in incised wounds. The vessels on the surface of the brain were full of blood, and the cortical structure appeared dark-coloured. The lungs were congested, but the heart contained little blood. The mucous membrane of the stomach presented a slightly pinkish hue, but that of the intestinal canal was nearly white. From the absence of any trace of effusion of blood, the sound condition of the exposed adipose tissue, its exemption from the action of the fire, and the irregular character and appearance of the fissures, Mr. Curling concluded that they were not the result of wounds inflicted before the occurrence of the burn; he considered them to have been occasioned by the influence of heat, which had forcibly corrugated the skin and completely destroyed its elasticity, and the superficial layer of fatty tissue being closely adherent to it, necessarily gave way at the same time. In several places some small vessels containing blood were observed running across the fissures; these, being more tenacious than the fatty tissue, had not yielded with it. This appearance alone was sufficient to negative the supposition of the infliction of wounds by cutting instruments. The production of the fissures might have been aided by the child's struggles immediately after the occurrence of the burn, but it did not appear that these were at all violent. The conclusion at which Mr. Curling arrived was justified by the facts; and the case is calculated to throw an important light on the accidental origin of fissures or wounds of the skin in cases of death from burns.

The conclusions which, it appears to me, we may draw from the foregoing statements, are:—1. That, as a general rule, when we discover marks of vesi-

cation, with effusion of serum, or a line of redness, or both, about a burnt part of the body, we are justified in saying that the burn has occurred during life. 2. That when these appearances are not met with, it by no means follows that the burn had not been produced in the living body; the affirmative evidence derived from such appearances being much stronger than the negative.

The subject of *scalding* scarcely requires a separate notice. A scald from boiling water would, when recent, be indicated by vesication and the sodden state of the skin. The living structures are not charred or destroyed as by the application of a red-hot solid. At the Liverpool Summer Assizes, 1847, a woman was convicted of throwing boiling water over her husband, with intent to maim him (*Reg.* v. *King*). In another case (*Reg.* v. *Blewitt*, Worcester Summer Assizes, 1847), the prisoner was convicted of the manslaughter of his wife by pouring over her the contents of a kettle of boiling water. At the Stafford Winter Assizes, 1859 (*Reg.* v. *Hill*), a man was convicted of feloniously casting boiling water over the prosecutor, with intent to do him grievous bodily harm. The medical evidence was to the effect that the scalds were on the head, cheek, neck, and arm, and were of a dangerous character. A woman at Glasgow attempted to kill her husband by pouring boiling water over his genital organs while he was asleep in bed. He died, but his death could not be clearly traced to this cause.

BURNS BY CORROSIVE LIQUIDS.

Among the cases in which medical evidence is sometimes required, are those of throwing mineral acids, alkalies, or other corrosive liquids on the person. This crime was at one time prevalent, and until the recent alteration in the criminal law there was no adequate punishment for it (24 & 25 Vict. c. 100, s. 29). On one occasion, an assailant escaped a charge of felony, because it could not be considered, in law, that sulphuric acid was capable of producing a *wound*—the man having been indicted for wounding! This case clearly showed a strong necessity for some legal definition of a wound, as well as the uncertainty of medical opinions: for while one surgeon considered that the injury produced was a wound, another thought that it was not. The judges decided that it was not a wound within the meaning of the Act. (*Rex* v. *Murrow*, Liverpool Autumn Assizes, 1835.) The statute above mentioned, while it punishes the offence, omits all reference to a definition of the word wound. The nature of the liquid thrown is merely defined, in general terms, to be 'any corrosive fluid or any destructive substance'—a point which will require medical evidence for its elucidation.

In common language, and according to the statute, the injury thus produced by a mineral acid such as oil of vitriol, is called a burn; but it is wholly different in its origin, as well as in its progress. I do not know that there has been a single instance in which such an injury has directly destroyed life; but great deformity and actual blindness have resulted. A medical man is sometimes required to distinguish these injuries from burns and scalds; this may be easily done, in the first instance, by the appearance of the part injured, as well as by the description of the first symptoms. The stain is brown when sulphuric acid has been used, and yellow when nitric or muriatic acid has been employed. The eschar or destroyed part is soft, and not dry as in a burn from a heated solid. The skin touched by a concentrated acid is destroyed and sloughs away, to the extent of the part on which the corrosive liquid was applied, leaving a suppurating and granulating surface. There is no capillary congestion or redness of the skin around the injury, as in a burn; but the colour of the injured part may throw some light upon the nature of

the corrosive substance used. Thus, while oil of vitriol (sulphuric acid) produces dark-brown stains, aqua-fortis (nitric acid) produces yellow or yellow-brown stains on the skin. Articles of dress are also differently coloured by these acids. The period at which a person may recover from an injury of this kind depends on the degree and extent of the injury, and the part affected by the corrosive liquid. Although a person may not die from the direct effects of the acid, yet in certain irritable constitutions the inflammation which follows in deep-seated parts may prove fatal. In infants, or delicate women, an extensive injury thus produced may readily destroy life. In one instance, sulphuric acid thrown on the face produced inflammation of the eye, for which bleeding was prescribed. The person died of phlebitis (inflammation of the vein), as the result of this bleeding (p. 587). In the case of Miss *Cashin*, for whom an escharotic liniment, containing nitric acid, was prescribed by a quack, there was no doubt that death was caused by the great local mischief produced by the application. The nature of the acid may be determined by applying wetted linen to the part when the injury is recent, and examining the liquid thus absorbed. In general, however, evidence is readily obtained by examining the spots or stains left on articles of clothing or furniture. Sulphuric acid is most commonly used: in a case which occurred at Guy's Hospital, nitric acid had been thrown at the person, and had led to the destruction of the sight of one eye. The caustic alkalies may also be used under these circumstances, as well as numerous other liquids, on which the only medical opinion required would be, whether the article employed should or should not be considered as a corrosive liquid or a destructive substance. To constitute a felony, it is not now necessary that the *person* should have sustained, from the act of throwing, any bodily injury. Unless vital reaction has taken place, there are no means of distinguishing the effects of a corrosive liquid on the living from those produced on the dead body. ('Ann. d'Hyg.' 1869, 1, 396.)

The mineral acids are sometimes used in other ways for the destruction of life. In June 1833, a man poured a quantity of strong nitric acid into the ear of his wife while she was lying asleep. She awoke suddenly with a violent pain in the ear, which continued for three days, whereby she became weak and exhausted. Soon afterwards there was copious bleeding, and a portion of membrane escaped. She lost the use of her right arm, and became completely deaf. Suppuration took place from the ear, and blood escaped daily. She gradually sank, and died six weeks after the injury, the right half of the body being convulsed before death. On inspection, a portion of the external ear was wanting, and the ear-passage was much wider than natural. The brain, near the petrous portion of the temporal bone, was softened, and the bone itself diseased (carious). The injury had led to death indirectly by producing disease of the brain. ('Med. Gaz.' vol. 17, p. 89.)

In a case tried at Aberdeen, a woman poured oil of vitriol down the throat of her husband, while he was lying asleep with his mouth open. She was tried, and convicted of the murder. In a more recent case, a woman killed her husband, by pouring a solution of corrosive-sublimate down his throat while he was sleeping. These, however, were treated as cases of poisoning, as death did not depend on the local or *external* mischief produced by the corrosive agent employed.

CHAPTER 51.

SPONTANEOUS COMBUSTION—ALLEGED OCCURRENCE OF CASES IN HUMAN BEINGS—IN THE DEAD BODY—ACCIDENTS BY FIRE—SPONTANEOUS COMBUSTION OF MINERAL AND ORGANIC SUBSTANCES—CONDITIONS FOR THE SPONTANEOUS COMBUSTION OF COTTON HAY AND OTHER SUBSTANCES—INFLUENCE OF OIL AND WATER—ALLEGED SPONTANEOUS COMBUSTION OF FLAX HEMP JUTE AND SILK—CASES REQUIRING SCIENTIFIC EVIDENCE.

It is nearly a century and a half since the hypothesis of the spontaneous combustion of the human body took its origin. It was readily accepted by those who could not in any other way account for the phenomena, and who were either incompetent or unwilling to reason correctly from recorded facts. At this date the facts connected with combustion, and the elements upon which it depends, had not even been discovered. All bodies were supposed to hold within them a principle of fire (*phlogiston*), which might be eliminated from them under certain conditions. When a person was found burnt, and no cause was apparent, the fire was supposed to have had a spontaneous origin, *i.e.* within the body of the deceased, and thus to have spread from the body to surrounding objects.

In medico-legal works cases are recorded, generally of ancient date, in which it was supposed the body had been spontaneously consumed by an inward combustion of the organs. In one of the earliest of these cases, that of a man of the name of *Millet*, of Rheims, who was charged with the murder of his wife by fire, the question of spontaneous combustion was raised in the defence, and led to the acquittal of the accused. This case rests upon the authority of Le Cat, and it is stated to have occurred at Rheims in 1725. It appears that the body of the deceased woman, almost entirely consumed, was found lying in the kitchen of the house at a short distance from the hearth. A part of the head only, with a portion of the legs, and a few of the vertebræ, had escaped combustion. The floor beneath the body was partially burnt. The prisoner, in his defence, stated that he and his wife had retired to rest on the previous evening; that his wife, not being able to sleep, got up and went into the kitchen, as he supposed, to warm herself. He was awakened by the smell of fire, and going down into the kitchen discovered the deceased lying near the hearth in the manner described. An intrigue with a female servant was considered to furnish a sufficient motive for the alleged act of murder, and the man was found guilty. On appeal to a higher Court, the sentence of death was revoked, and the prisoner was discharged on the ground that this was a case of spontaneous combustion. (Taylor's 'Elements of Medical Jurisprudence,' 1836, 1, 254. See also Liebig's 'Letters on Chemistry,' 1851, p. 281.) As far as the mode of death was concerned there was nothing in this case to indicate violence by another. The facts are explicable on the supposition that the clothes of the deceased were accidentally ignited. The almost complete destruction of the body appeared at that date to be inconsistent with the ordinary effects of fire, but subsequent observations have shown that this is an error. At the same time it is not improbable that the amount of destruction of the body was exaggerated. Other cases, in which the details are similar, have been recorded. It does not appear, however, that any one on whose judgment reliance can be placed has ever seen a case or recorded the details from actual observation. The hypothesis of such a mode of destruction of the human body is not only unsupported by any credible facts, but is as wholly inconsistent with all that science has revealed as witchcraft itself. In the instances reported which are worthy of any credit, a candle, a fire, or some other ignited body has been at hand, and

the accidental kindling of the clothes of the deceased was highly probable, if not absolutely certain. It is in vain that they who adopt this hypothesis appeal to the electrical state of the atmosphere or of the person, coupled with the impregnation of the tissues with the inflammable principles of alcohol, as conditions sufficiently explanatory of their views: such explanations may be reserved until the occurrence of this spontaneous combustion from internal causes is placed beyond any reasonable doubt. (For a minute description of the phenomena which are supposed to accompany this condition, see Casper's 'Wochenschrift,' 1841, Nos. 8, 9, 10; also Henke's 'Zeitschrift der S. A.' 1842, 2, 228; 1843, 2, 39; 'Ann. d'Hyg.' 1850, 2, 191 and 363; also 1851, 1, 99; 2, 383.) It is a curious indication of the utter absence of any philosophical spirit of inquiry, that this hypothesis of the spontaneous combustion of the human body should have ever found acceptance among educated persons. It need hardly be observed that there is nothing in the structure of the human body which is not equally found in the bodies of all warm-blooded animals. No one has even ventured to record a case of the death by spontaneous combustion of any domestic animal, for all experience would be adverse to such a statement; and the cases recorded as having occurred in human beings are either untrue, or are explicable as ordinary natural phenomena—the combustion of clothing or furniture, or the result of accident.

Some writers, who have rejected the doctrine of spontaneous combustion, have taken up the view that the human body may in certain cases acquire preternaturally combustible properties. Although they admit that fire is always applied from without, they at the same time contend that from the amount of animal matter found burnt, compared with the clothing or furniture which may have become ignited, the flesh, soft organs, and even bones must have been more combustible than usual. Such a theory as this, however, is not required to explain the facts. Dry animal solids readily burn, but the soft parts, either in the living or recently dead body, contain as much as 72 per cent. of water, which renders them highly incombustible. Until this large proportion of water is evaporated the substance does not undergo combustion. In many experiments made on different organs and on different bodies, I have not observed that different parts of the same body or the parts of different bodies have varied in their degree of combustibility. The bones alone have withstood a greater degree of heat, from the large proportion of earthy matter contained in them. The experiments have led to this result—the flesh and the organs generally are very difficult of combustion, and can be completely consumed only in a strong fire and under a powerful current of air. Experiments on the bodies of animals have shown that they possess the same property of difficult combustibility. The presence of fat or even of spirit in flesh does not render it combustible. The fat or the spirit will burn, but the flesh can only be burned by removing from it the substance which interferes with its combustibility—namely, water. There is not the slightest evidence to show that the parts of the body ever acquire increased combustible properties from disease. The theory, therefore, proposed to be substituted for spontaneous combustion, is wholly unsupported by evidence.

Liebig correctly observes: 'With respect to the fuel assumed to have been present in insufficient quantity, this is a very insecure supposition; for fire, the cause of death by burning, has this peculiarity—that it consumes the fuel or matter which supports it, so that the fuel does not remain unaltered, like the knife with which a man has been murdered. (Op. cit. p. 291.) It is, therefore, obviously impossible after a case of burning for any person to define how much fuel has been present before the burning commenced. That which remains is only a part of the fuel which has acted, and it is precisely that part which has disappeared or has been consumed that produces the effect.' (Liebig.) This reasoning might be carried a little further. Had the person

who gave this opinion of the comparative effects of burning fuel on the human body, ever had any experience of the nature and amount of fuel required to consume a given weight of flesh? It will be found on examination that the statement is a loose conjecture, without a single fact or experiment to support it.

In some cases of accidental burning in which *all* the facts were known, the body is stated to have been much destroyed, compared with the injury done to surrounding objects. In December 1864, a woman given to habits of intoxication was found dead in her room. Her clothes were on fire, and a chair had been burnt. The room when entered was filled with a thick black offensive smoke. On examination it was found that some of the bones were completely deprived of flesh. In the absence of a fire or a candle (which was still burning on the table) this might have been set down as a case of spontaneous combustion, or, by reason of the flesh being burnt from the bones, at least as a case of preternatural combustibility, whereas it was nothing more than a common casualty by fire.

It frequently happens that the skin is much injured by fire, while the muscles and soft parts beneath have suffered but little. There are some circumstances which may occasionally explain the different degrees in which parts of a body are found burnt. An assassin may have employed methylated spirit, naphtha, benzole, turpentine, or some inflammable liquid, of which no trace can be found; and the great destruction of the body may therefore be due to this extraneous cause, and not to any increased combustibility of its parts. A short exposure to a large volume of flame, owing to its high temperature, will speedily char the flesh and consume it. Articles of female dress, from the quantity of air enclosed between the layers, are capable of producing a considerable volume of flame, which is heat at its maximum degree, and thus the bodies of women are sometimes extensively destroyed, as a result of the accidental burning of the clothes (p. 694). Even allowing that parts of the human body might, in certain cases, acquire increased combustible properties, the medical jurist will perceive that this admission does not involve any difficulty in the judicial determination of a question of murder by burning; since it is contended that the combustion of a body cannot possibly take place except by contact with some substance already in a state of combustion. But whether the ignition of the clothes of a deceased person took place accidentally, or by the criminal act of another, is a totally different question: it is one in which a medical jurist is not concerned—it can be cleared up only by general and circumstantial evidence. Assuming that the body of one person will burn more rapidly and completely than that of another, this will be no answer to a charge of causing death by fire. If urged in defence, that the prisoner might not have intended to destroy the deceased, and that although he ignited the clothes he did it without any malicious intention, and that death would not have been caused by his act but for the preternatural combustibility of the body—the obvious answer is that the intention which a person may have had in setting fire to the clothes of another, when he could not possibly know to what degree the burning would extend, is a question for a jury, to be decided from the circumstances. An unnatural degree of combustibility would not probably form an 'extenuating circumstance' under the French code of law. The relation of this subject of the alleged spontaneous combustion of the body to medical jurisprudence appears therefore to have been much exaggerated.

Such a defence as spontaneous combustion might afford, would, if admitted, prove most convenient to those assassins who had endeavoured to conceal their acts of murder by burning the bodies of their victims. Fortunately for the ends of justice, all the facts connected with a murder are now so rigorously in-

vestigated, and generally admit of so reasonable an explanation, that such an appeal to the ignorance of a jury would avail but little. In the case of Mrs. *Pulley*, whose body was examined by the late Mr. Jackson, of Stamford, in 1860, the circumstances were such as to require but little ingenuity to transform them into a case of spontaneous combustion, although a proper inquiry showed that it was a deliberate murder by strangulation. There was a subsequent burning of the body by means of the clothes, in order to efface the marks of a violent death. The deceased was found lying on the hearth of her room, about three or four feet from the grate. From the shoulders downwards, the body was lying on a boarded floor of oak. The deceased was fully dressed, and parts of her clothing and body had been destroyed by fire. A brass candlestick was lying between the left arm and the body, the top of the candlestick being inclined towards it. The clothes were wholly burnt off both arms, and partly off the upper portion of the trunk. The legs were not at all burnt. A bonnet which the deceased wore was partly burnt. The right arm was elevated by the side, with the elbow resting on the floor. The fingers were partly burnt off, and the remainder of the hand was charred. The left hand, which was stretched out, was not so much burnt as the right. Some ashes from the clothing lay between the left arm and the body, which was not elevated above the floor. The fire was extinguished, but there was a strong smell of burning in the room when it was entered. There had been no fire in the grate. Under the body there was a hole in the oak-floor, which had been produced by burning. The features were distorted and swollen, and the eyes suffused with blood. Some parts were burnt to a cinder—others were but little affected by the fire. In order to convert this case into one of spontaneous combustion, it would be simply requisite to ignore the candlestick, and to contend that, as some parts of the body were burnt to a cinder while others were but little affected, the burnt portions of clothes would not furnish a sufficient quantity of fuel to explain the facts! This case is in some respects similar to that of *Millet* (p. 699), but the defence of the man who committed this act of murder did not rest upon spontaneous combustion.

The advice of Baron Liebig, in reference to the duties of medical men in cases of alleged death from burning, is deserving of the notice of medical witnesses:—'In cases of fire, when the investigation is extended to all those who had access to the place where it broke out, it often happens that the incendiary or the actual originator of the fire is discovered. Legal medicine, even if the theory of spontaneous combustion were true, which it is not, ought not to interfere in so simple a proceeding, justified as it is by experience, until all other probable causes of fire have been excluded. If such interference take place, those who adopt this course deprive science of its proper rights, and become partakers of the incendiary's guilt; they protect the criminal by misleading those whose duty it is to conduct the investigation. The physician who is called in to give evidence in such cases can only say, if he act according to duty and conscience, in what state the body was found—whether the injuries from burning took place before or after death—whether death was caused by fire alone, or before the action of the fire, by other means, such as wounds, strangulation, or a blow on the head, &c. In no case is it permitted to him to explain anything he has not seen, by means which he has also not seen, or by a theory which he cannot understand.' (Op. cit. p. 311.)

Cases of alleged spontaneous combustion dependent on accident or homicide.—The following medico-legal case occurred in France. On the 6th of January 1847, the body of a man was found lying in bed, and in a state of combustion, by some persons who entered his bedroom in the morning. The chamber was filled with a dense smoke, and one of the witnesses asserted that he saw, playing around the body of the deceased, a small whitish flame, which

receded from him as he approached. The clothes of the deceased and the coverings of the bed were almost entirely consumed; but the wood was only partially burnt. There were no ashes, and there was but a small quantity of vegetable charcoal: there was, however, a kind of mixed residue, altered by fire, and some pieces of animal charcoal, which had evidently been derived from the joints. The deceased was in the habit of carrying lucifer-matches in his waistcoat-pocket, and, according to his usual practice, he had had a hot brick placed at his feet when he went to bed the preceding evening. Two hours afterwards his son and daughter-in-law passed by the door of his room, but there was nothing which attracted their attention. It was only the following morning, early, that his grandson found his body in the state described. The deceased was 71 years of age. He was not fat, nor was he addicted to drunkenness. The temperature of the air was low; there were no indications of electricity. The son and his wife were suspected of having murdered the deceased, and afterwards burnt the body in order to conceal the traces of the crime; and Dr. Masson was commissioned to investigate the case. The body, which had been buried, was exhumed and examined. The cravat, partially burnt, was still around the neck, and part of a sleeve of a nightshirt was found. The hands, completely burnt, were also attached to the forearms by some carbonized tendons, which gave way on the slightest touch. The thighs were detached, so as to resemble a wilful mutilation, but for the discovery of animal charcoal about them. From these facts, Dr. Masson considered it impossible to ascribe the changes to the effect of accidental burning; and as they could only be produced by violent combustion continuing for some time, he drew the inference that the burning must have resulted from some inherent cause in the person, probably roused into activity by the hot brick placed at the feet of the deceased! The burning once commenced, would be easily supported by the state of the tissues! Hence the case was, in his opinion, to be referred to the class of spontaneous combustions. Orfila is reported to have coincided with Dr. Masson in this opinion, and the accused were acquitted. ('Gazette Médicale,' Sept. 4, 1847.) It is quite possible that the accused had not caused the death of the deceased, for, so far as the description goes, the man might have been accidentally burnt after he had retired to rest. With respect to the medical opinion, that a long-continued action of a strong heat was necessary in order to produce the effects observed, it may be remarked that it is not possible to assign the degree of the duration of the heat which is required to produce particular effects on the body. It appears far more probable that Dr. Masson had underrated the effects which are liable to follow from an accidental ignition of the clothes, than that a warm brick placed at the feet should excite spontaneous combustion in the body, and convert the joints into animal charcoal!

It is singular that, so recently as the year 1850, some German physicians should have been found to advocate the hypothesis of spontaneous combustion in a case of murder. A trial took place at Darmstadt in March and April 1850, in which a man named *John Stauff* was charged with the murder of his mistress, the Countess of *Goerlitz.* This lady was found dead in her apartment; the dress on the upper part of the body was almost wholly consumed; the head exhibited the form of a nearly shapeless black mass, in which the mouth was imperfectly distinguishable, with the charred tongue protruding from it. The skin of the neck, as well as the skin and muscles of the face and upper part of the chest, were much blackened and charred. The joints of both arms were charred on their surfaces, and the blackened ends of the bones protruded. There were no marks of fire on the clothes anywhere beyond the margins of the burns on the body. A writing-desk near the body had been partially burnt, and the floor beneath and in front of the desk, over a space of

a foot and a half, had been entirely consumed. The feet of a chair placed near the writing-desk were slightly charred. A folding-board and the drawers were also much burnt. With this clear evidence of the partial destruction of a human body by fire, the physician who was consulted could suggest no other explanation of the facts than that the body of the Countess must have taken fire *spontaneously*, while she was engaged in writing at her desk! He could not even admit that her cap or dress might have become, by some not uncommon accident among women, ignited by a candle; because, had this been the case, she would, in his opinion, have had time to escape or call for assistance! The other reasons assigned for the adoption of this hypothesis were, that deceased went to bed in good health, that there was a greasy black or sooty substance found about the room, and that the body exhaled an empyreumatic odour. It may be observed that when the room was first broken into, and the Countess was found dead, flames burst out simultaneously from the hangings, the writing-desk, and the floor beneath it, which required to be extinguished by the ordinary process—namely, by water. The scientific opinion thus given amounted to this, the Countess's body had undergone slow combustion until it reached a full red-heat; it then ignited the furniture around—the reverse of the process by which, according to experience, persons are usually burnt to death! The Countess was thus found dead in her chamber on the 13th of June 1847. On the 26th of November of that year, it was intimated to the Count that an inquest would be held; and the valet Stauff, having in the meantime made an attempt to poison his master, was then first suspected of having murdered the Countess—the death by burning having up to this time been treated as an accidental occurrence. The body, which had been buried, was not exhumed until the 11th of August 1848, *i.e.* fourteen months after death: it was subjected to a special examination, and the Hessian Medical College, to which the case was referred, came to the conclusion that the Countess had not died from spontaneous combustion. The case was subsequently referred to Prof. Liebig and M. Bischoff, of Giessen; and their report was issued in March 1850, at which date the man Stauff was put on his trial. They found no difficulty in concluding that a murder had been perpetrated, and the body wilfully burnt *after death* for the purpose of concealing the crime. There was some doubt whether the deceased had died from strangulation, or from violence to the head. Stauff was convicted chiefly upon circumstantial evidence. He subsequently confessed that the countess had entered her room as he was in the act of committing a robbery. A struggle took place; he seized her by the throat, strangled her, and afterwards placed the body in a chair, piling around it combustible articles of furniture. He set fire to these with the view of destroying the proofs of his crime. It will be observed that the tongue was found protruded, as it is in violent strangulation, and that in its charred state it retained the position given to it by the act of murder.

One of the supposed scientific difficulties in this case was, that the body *appeared* to have been so much consumed compared with the amount of combustibles near it. This, however, seems to have been a mere conjecture. Another point which excited notice was, that the clothes were not consumed beyond the margins of the burns on the body—a circumstance which has been hitherto regarded as a special characteristic of spontaneous combustion, although it simply shows that when the clothing burns without producing much flame, the burns on the body are defined by the clothing actually consumed. The dark greasy matter on the furniture and the empyreumatic smell are also conditions which by this case are proved to be the results of homicidal attempts to conceal a foul murder, and they are not, in any sense, indications of spontaneous combustion. They are always produced when there is a low or smothered combustion of animal matter. (See, for a further report of this

case, a paper by Dr. Tardien, 'Ann. d'Hyg.' 1850, 2, 191, 363, and 1851, 1, 99, also a paper by Dr. Ogston, 'Medical Gazette,' vol. 46, pp. 889 and 948.)

The only recent case of any note in reference to this subject is that reported by Dr. Bertholle ('L'Union Médicale,' Nov. 19, 1870, and by Dr. Strohl, 'Ann. d'Hyg.' 1871, 1, 228.) The case was that of a woman addicted to drinking alcoholic liquids to excess, including *absinthe*. On the 1st of August 1869, having drunk largely, she went into her bedroom, about 5 P.M., and two hours afterwards, her husband, in attempting to enter the room, found the door so hot that it gave him the sensation of burning. An alarm of fire was given and the room was entered by a window. There was a nauseous odour and a sense of suffocation on entering. The dead body of the woman was found on the floor between the bed and the hearth—the head being partly under the bed, and the legs across the hearth. There was no fire in the grate, and the trap was down. The floor on which the body was lying was more carbonized than burnt, and on it were found fragments of bones,—some of the ribs, a hand, and incinerated remains. The head, which was swollen and of a violet-red colour, presented no mark of burning. The hair was not burnt. The upper part of the trunk was not burnt, but was covered with a black powder, the residue of the burnt clothing. The left arm had disappeared from the shoulder. The right arm had lost the hand, which was disarticulated at the wrist. The elbow joint was exposed, but the muscles of the arms were not destroyed. The left side and front of the chest were widely open, but there was no trace of the thoracic viscera. The lower ribs were separated. The walls of the abdomen were gone,—its cavity was empty, the viscera being reduced to a greasy black soot adhering to the vertebræ. The bones of the spine and pelvis remained, but the muscles and fasciæ had disappeared. The lower limbs from the thighs downwards were entire, the skin being covered with a black powder—but there were no blisters or vesications on these parts.

It is further stated that, although there was no apparent source of fire or ignition in the room—and the bed and its furniture had escaped burning,—the floor was still burning, but without flame, when the room was entered. No combustible in the shape of candle, matches, or fuel was found near the body. No noise or cry of alarm, was heard, and the people living opposite saw no light or flames in the chamber or smoke issuing from it.

The complete destruction of the clothes by burning in this case shows that the fire was *ab extra*, and although no sources of combustion were found in the room, still this does not preclude the possibility of an accident from this source. The woman may have had matches about her, and in her intoxicated state an accident may have easily occurred, by which her clothes were ignited and led to the combustion of the body as well as of the matches. This, at any rate, is more probable than the theory that the viscera of her body should have spontaneously acquired such a temperature as to lead to the complete destruction of her clothing! A case like this, in the absence of such a strict examination of the facts as would take place in a court of law under a criminal charge, proves nothing in favour of the theory of spontaneous combustion. It is similar in its details to that of Mrs. *Pulley*, a case of murder with an attempt at concealment (p. 702). The unequal burning of the body was observed in both cases.

It could scarcely be supposed that the question of the spontaneous combustion of the *dead* human body would present itself for consideration, yet the following case in which I was consulted by Mr. Worthington of Garston, near Liverpool, in March 1867, bears upon this point. In the winter of 1865, a gentleman, æt. 30, died in the south of England of typhoid fever. It was noticed that there was great tympanitis. His remains were brought to Garston and interred in the family vault in the parish church. The body was in a shell

enclosed in a patent metallic coffin and an oaken one. About thirteen months after the burial a foul smell was perceived in the church, and it was found to issue from a crevice in the floor immediately over the vault in which the coffins had been placed. The vault was opened, and it was then found that the coffins in which the body was placed had burst opposite to the breast, and liquid matter was oozing from the body. The coffins were filled with sawdust and the vault was left exposed for the night. The gas, which had been lighted in the church during the exploration, was turned off at the meter, and, as it was supposed, all was left quite safely. The next morning, when the workmen entered, the vault was found to be on fire, burning, as the sexton said, with a bluish flame and a most offensive smell. By throwing water and earth on the burning mass the flames were extinguished, and it was then found that the wooden coffin of the deceased gentleman and his remains were entirely consumed, with the exception of the silver coffin-plate and a portion of the intestines. Another coffin in the same vault, at a short distance from it, was slightly burnt at the side.

My informant observes that for such a complete destruction of the body to have taken place, the fire must have been going on for some hours before discovery. None of the woodwork or any other part of the church was injured, and the place was found secure as on the previous night. As there was nothing to show the probability of the accidental or intentional access of fire, the question arose whether spontaneous combustion could have taken place. Many persons set it down to this cause, but Mr. Worthington found, by rigorous inquiry, that one of the workmen had been smoking in the vault, and might have carelessly thrown down the lighted paper which he used. This may have kindled the cloth covering of the coffin and sawdust, and assuming that the gases issuing from the body were of a combustible nature, like those described as issuing from dead bodies advanced in putrefaction (pp. 95, 112), the results might be accounted for without reference to the theory of spontaneous combustion. The only inexplicable fact of the case is, that the bones are stated to have entirely disappeared, as these are chiefly formed of incombustible mineral matter—phosphate and carbonate of lime. Dead bodies may, as it has been elsewhere stated (pp. 52, 98), emit light and heat, and evolve inflammable gases. But these gases require a full red-heat, in order that they should burn and produce the usual effects of burning. In this case the sawdust no doubt acted as fuel, and thus led to the complete burning of the body.

Time required for the burning of a dead body.—It may be a medico-legal question whether, on discovering a body much burnt, it could be determined from its appearance how long a period it would require to produce the amount of destruction observed. An answer to such a question may be necessary, in order to connect a person with the perpetration of an alleged crime, but the question does not admit of a precise answer. A conjecture only can be formed from the facts proved in each particular case. The human body contains a large proportion of water (72 per cent.); this gives to the soft structures a power of resisting combustion. At the same time there is a quantity of fat in the body, varying in different parts, but amounting to an average of about five per cent. The fat or oil tends to increase its combustibility, and this is still further increased if it is placed on any combustible article which can imbibe it, such as a rug or a deal-floor. The nature of the dress will also make a difference. Under a strong and active flame, which might subsequently burn out before the discovery of the body, there would be a degree of destruction in half-an-hour which a more slow and smothered combustion would not effect in several hours. In the case of the Countess of Goerlitz, it was proved that she had retired to her room between three and four o'clock in the afternoon: the Count returned at seven o'clock, and knocked at the door of her anteroom, but receiving no answer he again went out. Had the burning of the body then commenced, he

would have perceived it by the smell, or by the appearance of smoke. He returned again at nine o'clock; and during this second absence, covering an interval of *two hours*, a bright light had been seen at one of the windows, and a thick smoke issued from one of the chimneys. There is a little discrepancy as to the time, but, taking the maximum, the amount of destruction described in this case must have occupied less than two hours, and probably not more than one hour.

This question actually arose in *Reg.* v. *Hatto* (Aylesbury Lent Assizes, 1854), in which I was consulted. The deceased, a female, was found dead in her room, and her body much burnt. She was last known to be living at about a quarter-past eight o'clock in the evening, and her body was found, still smouldering with fire, on the floor of the room at about a quarter-past eleven o'clock. The only persons known to have been in the house were the prisoner and deceased. The prisoner pretended that he knew nothing of the circumstances attending her death, and endeavoured to make it appear that robbers might have broken into the house and committed the murder, at some period of the three hours during which he alleged that he was asleep in bed. For the prosecution, it was suggested, in order to exclude this hypothesis—which, however, was sufficiently excluded by other facts—that the act of murder, with the attendant burning, must have occupied the whole of the time intervening between the period at which deceased was last seen living, and the period at which her body was found. The medical gentleman who examined the deceased found that 'both knees were consumed by fire, and the thighs, as well as the private parts, were burnt to a cinder—leaving the shafts of the thigh-bones exposed and charred for several inches. Between the thighs and the feet, the floor underneath had been burnt away, and the leg-bones had fallen through the floor, leaving the feet unburnt on the floor.' He expressed an opinion that it would take from two-and-a-half to three hours in order to consume the body to this degree; thus covering the whole interval during which deceased and prisoner were in the house together. It should be stated that the clothes of the deceased were much burnt, and that beneath the body there was a hempen mat, so combustible, owing to the melted human fat with which it was impregnated, that when ignited I found that it burnt like a link. The guilt of the prisoner did not depend on an answer to this question; that was made sufficiently clear from other circumstances proved in the case, which were quite inconsistent with his innocence. It is obvious that an opinion on such a subject must be in all cases conjectural, since the effects, *cœteris paribus*, depend as much on the intensity as on the duration of the heat. It was indeed just as probable, medically speaking, that, with a large body of flame, the amount of injury met with might have been produced in an hour as in three hours; and if the question were proposed to any number of medical men, in entire ignorance of the bearing which their answers would have on the case, there would probably be no two answers alike. The confession of the prisoner subsequently made, shows that the burning observed must have taken place in less than two hours, and perhaps within an hour and a half. The *Goerlitz* case and some others prove that a short period may suffice for a large amount of destruction, and that, judging by what remains, the combustible materials consumed appear to bear only a small proportion to the parts of the body burnt. This may be accounted for by the large volume of flame produced during the combustion of female articles of clothing; and flame is matter ignited to the highest temperature.

SPONTANEOUS COMBUSTION OF MINERAL AND ORGANIC SUBSTANCES.

Although there is an entire failure of evidence to show that the animal body is liable to spontaneous combustion, there is good reason to believe that

this phenomenon may occasionally manifest itself in certain organic and mineral substances, and cause destruction of life and property. Under these circumstances, a person may be unjustly charged with an act of incendiarism, and the proof of his innocence may depend upon the skill and knowledge of a scientific expert who is required to investigate the case. Evidence on this subject may be demanded in cases of marine insurance, in which it is alleged that ships and their cargoes have been destroyed by spontaneous combustion; or where articles of merchandise have been accumulated in a populous neighbourhood, and life and property are said to be endangered by their liability to accidents of this nature.

Towards the latter part of the last century several fires occurred in the Russian navy, as well as in the warehouses on shore. These were attributed, in the first instance, to acts of incendiarism; but it was subsequently discovered that they were owing to the spontaneous heating and ignition of large quantities of hemp and flax impregnated with oil. Experiments were made on the subject by the Imperial Academy of Sciences; and it was shown to the satisfaction of the Russian Admiralty that such materials, when heaped together in buildings and allowed to remain for some time, would, under a sufficient access of air, ignite spontaneously. (Paris and Fonblanque, 'Med. Jur.' vol. 1, p. 410; also 'Annales d'Hygiène,' 1841, 1, 364.) The great fire in Plymouth Dockyard, in 1840, was supposed to have arisen from a similar cause, although there was also a strong suspicion that this was the act of an incendiary. On a recent occasion an injunction was sought for against certain merchants for the storage and drying of jute on premises in the vicinity of which there was much valuable property. It was alleged, among other grounds, that jute, in the wet state, was liable to undergo spontaneous combustion. The subject is therefore of practical interest, and requires consideration from a scientific witness.

Mineral substances.—The facts connected with the spontaneous ignition of mineral substances are generally known to, and seldom admit of doubt among, scientific men. The mere exposure of a variety of substances to the air, at any temperature, is sufficient to cause their combustion almost instantaneously. Phosphorus dissolved in sulphide of carbon furnishes an instance of this kind. If the solution is poured upon paper, so soon as the solvent has evaporated the particles of phosphorus are left on the paper in a minutely-divided state. By their sudden combination with oxygen, sufficient heat is produced to cause inflammation of the phosphorus. It burns, but the flame does not readily kindle paper or other combustible substances. Tartrate of lead and Prussian-blue heated in tubes yield respectively lead and iron in a very finely-divided state. When the tubes are broken, and the powders are brought into contact with air, the metals are instantaneously oxidized, and burn with a bright light. These substances are well known as pyrophori. Spontaneous combustion is in these cases owing to the state of extreme division of the particles of matter, and to the heat produced by instantaneous oxidation over an extensive surface. This heat is sufficient to render the small metallic particles incandescent. Some substances in the state of vapour or gas, as phosphide and silicide of hydrogen, burn at once with a volume of flame on exposure to air. The combustible substance is here placed in a state most favourable for sudden ignition at the common temperature of the atmosphere.

Ordinary *Charcoal* does not undergo combustion in air until it has been heated to a temperature of from 1000° to 1200°; but it would appear that in some states it is liable spontaneously to acquire a temperature which may lead to its unexpected combustion. Liebig asserts that there is no example of carbon alone, even in the finest state of division, combining directly with oxy-

gen at common temperatures, but that numerous facts show that hydrogen, in certain states of condensation, possesses this property. Lampblack, which has been heated to redness, may be kept in contact with oxygen gas without forming carbonic acid; but lampblack impregnated with oils which contain a large proportion of hydrogen gradually becomes warm, and inflames spontaneously. He also assigns the spontaneous inflammability of the charcoal used in the manufacture of gunpowder to the hydrogen which it contains in considerable quantity; for during its reduction to powder no trace of carbonic acid can be detected in the air surrounding it. This gas is not formed until the temperature of the mass has reached a red-heat, *i.e.* 980° to 1160°. ('Organic Chemistry applied to Agriculture and to Physiology,' p. 263.) The heat which produces combustion, therefore, in Liebig's opinion, is not caused by the oxidation of the carbon.

Some years since a ship, laden with casks of *Lampblack*, sailed from Portsmouth. In about six weeks afterwards a strong smell of burning was perceived to issue from the forehold, accompanied with smoke. On examination, it was found that a large cask of lampblack was giving out volumes of smoke, although not actually in flames. It was with some difficulty, owing to the intense heat of the cask, that it could be got on deck and thrown overboard. It was presumed that the admission of air to the interior of the cask would have caused its instant ignition. In consequence of this discovery, the whole of the lampblack on board, to the number of sixty-one casks, was thrown into the sea, and several of them were observed to be in a state of smothered combustion. The casks were surrounded by a number of barrels of tar and jars of oil, and it is probable that, owing to leakage, oil had become mixed with the contents. No light had been allowed in the hold since leaving England, hence there was no apparent source of external ignition. It was highly probable from all the circumstances, that it was a case of spontaneous combustion such as Liebig has described. ('Ann. d'Hyg.' 1841, 1, 343.) In July 1865 a fire took place at the Doncaster railway station, which was attributed to the spontaneous combustion of lamp-black.

According to M. Aubert, a French engineer ('Annales de Chimie,' 1831), recently-made charcoal in a fine state of division is liable to become spontaneously ignited without reference to admixture with oil. He states, as the result of his observations, that when recently-made charcoal was reduced to a very fine state of division, it rapidly absorbed air and aqueous vapour, especially the former. The air underwent no change up to the moment at which combustion ensued; but a considerable quantity of heat was extricated, which this experimentalist found at one time to be equal to 350° F. The greatest degree of heat was observed to be in the centre, or about five or six inches below the surface; and it appears that ignition first commenced here, if there were a tolerably free access of air. M. Aubert found that the most inflammable charcoal required to be in masses of at least sixty pounds in order that combustion should take place spontaneously, and the less combustible the charcoal, the larger the quantity required to be collected in a heap. In all these cases the charcoal was pulverized, and the shorter the time suffered to elapse between its manufacture and its pulverization, the more certainly and rapidly did combustion take place.

I have found by experiment that freshly-made charcoal introduced into a mixture of oxygen and sulphuretted hydrogen in explosive proportions, suddenly became intensely heated and caused the gases to combine with explosion. It has been long known that charcoal rapidly absorbs and condenses gases and vapours up to a certain point, but oxygen as it exists in the air is much less absorbed than others. It has also been observed that, whether there is chemical union or not, this absorption is accompanied by a slight elevation of

temperature. That it should be sufficient to reach 1000°, and thus ignite the mass, is not probable—at any rate, no danger has been apprehended by English chemists from the accumulation of large quantities of charcoal on one spot. M. Chevallier, however, in a paper on Spontaneous Combustion, has referred to several instances of the ignition of charcoal by spontaneous heating. ('Ann. d'Hyg.' 1841, 1, 339.) M. Robin describes a case in which finely-powdered charcoal recently prepared became ignited. (Op. cit. p. 342.)

Coals containing pyrites.—There have been many instances of the ignition of coals as a result of the presence in them of certain kinds of iron-pyrites, and actions for damages to merchandise have been brought. When water comes in contact with a large heap of coals containing pyrites, a chemical action takes place whereby the mass is heated; and if favourably placed for the retention of heat, as in the hold of a ship, the effect may be the heating of the coals to the point of combustion, and the destruction of the vessel and cargo. Several cases have come before our Courts of Law in which damages have been claimed for loss of freight or cargo, as a result of the combustion of coals under these circumstances. In *Michael* v. *Gillespy*, C. P. 1856, an action was brought to recover freight on a time-policy. Plaintiff entered into a charter to convey a cargo of coals to Aden from the Tyne. While in the Tyne, the ship was found to be leaky, but the leak was stopped. The coals were put on board, and plaintiff insured the ship in a time-policy for 300*l.* to cover the freight. The ship soon after sailing encountered a storm and put into Cuxhaven. The coals were landed and it was found that they were much wetted with salt water. The captain was advised that it was dangerous to re-ship them in that condition, as they were likely to ignite from spontaneous combustion, and as it was considered impossible either to dry them or to wash the salt out of them, the cargo was not re-shipped, and the plaintiff claimed under the policy for a total loss of freight. The defendant contended that the plaintiff knew that the ship was leaky, that the cargo was not lost by the perils of the sea, that the coals might have been re-shipped without danger—and if washed with fresh water and dried there would have been no spontaneous ignition. On these points there was conflicting evidence. The jury found for the plaintiff.

A similar case occurred in 1859. A vessel took in a cargo of 640 tons of coals at Hartlepool. In commencing her voyage she shipped much sea-water, whereby the coals were wetted. From an apprehension of spontaneous combustion, the coals were landed at Lowestoft, and a claim made for loss of cargo. It was contended that the captain was not justified in landing the coals. Mr. Dugald Campbell was consulted in this case. He examined the coals; they were then in a pile from six to nine feet in height, and were of a much higher temperature in the interior than on the exterior. They contained iron-pyrites, and had begun to undergo disintegration from the chemical action of the sea-water. As there was no combustion after landing, it was inferred that the coals might have been safely conveyed to their destination. Further, it was suggested that had the sea-water been washed out of them by ordinary water, or had they been transferred at once to another ship, spontaneous combustion would not have been liable to occur. That there was no combustion after landing was very properly explained by the fact of the coals being so spread out as to allow of a cooling effect by the air; secondly, whether wetted with salt-water or fresh was of little moment—if combustion took place at all, it would as readily occur with one kind of water as the other; and thirdly, if transferred to another ship in a wet state, combustion would have taken place more readily when the coals were accumulated in the dry hold of a vessel, where the air could have no cooling power.

The experiments of Frankland ('Chemical News,' 1862, v. 6, p. 3), show that a full red-heat, visible in daylight (1160°), is required for the ignition of the

gases derived from coal. In the decomposition of water, a very offensive inflammable gas is evolved—namely, sulphuretted hydrogen. This would give warning of the chemical changes which were going on, and long before an igniting temperature was reached, much aqueous vapour, mixed with a thick yellow smoke, having an offensive tarry odour, would be perceptible. The coals of some localities are especially liable to these changes, by reason of the large quantity of pyrites (sulphide of iron) associated with them. The Yorkshire coals from Hull, and some varieties of coals from South Wales, have given rise to these accidents. The pyrites which most readily undergo spontaneous combustion are those in which the protosulphide is associated with the bisulphide of iron. (Dumas' 'Traité de Chimie,' vol. 3 p. 59.) Too much water or too great an exposure to air will counteract the heating process. The intense heat produced by the slaking of fresh-burnt *lime* on which water has fallen is sufficient, when in a large mass, to account for the ignition of combustible bodies with which it is placed in contact. The substance is not itself combustible, but by the chemical action of water a degree of heat is produced which may cause the combustion of coal, wood, or other articles.

Sulphur, although highly combustible, has no tendency to spontaneous combustion. It does not absorb oxygen or combine with it below a temperature of 400°, which can only be reached by its receiving heat from some external source. Sulphide of carbon—the vapour of which is more inflammable than the vapour of alcohol, ether, and wood-spirit—takes fire at a black-heat, and according to Dr. Frankland, at a temperature as low as 300°. ('Chem. News,' 1862, vol. 6, p. 4.) There is no gas or vapour which is kindled into flame at so low a temperature as this. Coal-gas, the vapours of alcohol, ether, oil of turpentine, and benzole require a full red-heat visible in daylight (1160°), for burning with flame. Wood-spirit vapour also requires for ignition a red-heat, but it is more easily kindled than those above mentioned, and the flame spreads rapidly. I have not found any of these inflammable vapours to ignite at the melting-point of lead (620°), while the vapour of sulphide of carbon takes fire before it touches the melted metal. In one instance that came to my knowledge, there was reason to believe that the vapour of sulphide of carbon in an India-rubber factory was ignited by solar heat traversing glass, as it was supposed, from a refraction of the sun's rays.

It is necessary here to advert to an error which appears to prevail respecting the vapours of inflammable liquids. It is supposed, because the liquids are highly combustible, that the vapours which they give off at common temperatures or at a low degree of heat are spontaneously inflammable, or are liable to be inflamed at a very low temperature. The above-mentioned liquids give off vapours at different temperatures, which are combustible if a flame or visibly red-hot metal is brought directly in contact with them, but not otherwise. In this respect they do not differ from the most inflammable gases, such as hydrogen and coal-gas, which are not ignited by a temperature below a visible red-heat (1160°); and unless this temperature is reached, the vapours and gases do not take fire. The liquids differ in their volatility. Sulphide of carbon is entirely converted into vapour at 110°—wood-spirit or naphtha at 140° to 150°—alcohol at 174°—coal-naphtha at 176°—and oil of turpentine at 312°; but these liquids evolve a highly inflammable vapour at temperatures below 100°; and this vapour, if accidentally kindled by flame or a red-heat, may spread destruction. Those combustible liquids are safe which evolve no vapour at common temperatures, but burn only with a wick; *e.g.* colza-oil, rectified paraffine oil, and petroleum, when freed from the highly volatile hydrocarbon vapours which are generally associated with it. The Petroleum Act limits the storage of this liquid near dwellings, in reference to any sample which gives off an inflammable vapour at a temperature below 100° of Fahrenheit's

thermometer. ('Chem. News,' 1862, vol. 6, p. 169.) This has been taken by some to imply, that the vapour is actually inflammable at this low temperature—whereas it merely implies that those liquids are dangerous, when stored in large quantity, which give off, at or below 100°, a vapour that will take fire by contact with flame, or solids heated to full redness. Solids which give off no vapours below their temperature of combustion (such as dry flax, cotton, or jute), although highly combustible, are not dangerous in a like degree. Vapours may be ignited at a distance from the liquids, and fire will instantaneously spread throughout the mass with explosive violence—whereas in dry solids of the nature above described, flame or a red-hot solid must be directly applied to them to cause combustion: and although they burn readily, combustion is not so rapid as with inflammable liquids.

Phosphorus. Lucifer Matches.—Phosphorus, when in a dry state, has a great tendency to ignite spontaneously. As it undergoes oxidation at all temperatures when exposed to air, and its igniting-point is lower than that of any other solid, there is always danger unless this substance is kept in water. I have observed it to melt and take fire (when touched) in an apartment in which the thermometer was under 70°. In experiments on this substance in the dry state, I have found its melting-point to be 113°. It may be heated in air to a temperature of 110°, without melting or inflaming, and it does not inflame until after it has melted. Even when perfectly fluid at 113° it does not take fire until the surface is touched. At 120° it melts and burns readily. The ordinary lucifer-match composition takes fire at about the same point (120°). During the summer this composition is luminous in the dark, a fact which shows that oxidation is going on, and, therefore, a process of heating. Hence large quantities of these matches kept in contact may produce a heat sufficient for ignition. Still it is rare to hear of spontaneous combustion from them, and when they become ignited it is probably the result of some mechanical cause. The slightest friction is in some instances sufficient for this purpose. I have seen them ignite as a result of exposure to the sun's rays for the purpose of drying: they ignited in an attempt to remove them. Red or allotropic phosphorus mixed with chlorate and nitrate of potash forms a paste for wax-matches. In order to ignite this composition, a temperature of 159° is required. Some samples have resisted a heat of 200°, and have only slowly undergone combustion when kept for some time at a temperature of 212°. I have noticed that dry oxide of phosphorus will spontaneously take fire at common temperatures. Mixtures of solids containing sulphur are not liable to spontaneous combustion, although they will burn from a slight increase of temperature by friction or otherwise. In reference to *Gunpowder*, there is no instance recorded, so far as I am aware, in which this substance has spontaneously ignited. Of its three constituents, nitre has no tendency to undergo any change, and is not itself combustible. Sulphur does not ignite under 400°, and charcoal not below 1000°. The finest gunpowder requires a temperature of 525° for its inflammation and perfect combustion. There is no tendency to spontaneous heating in a mass, the charcoal forming only one-eighth part. If such a tendency existed, the nitre, which forms three-fourths of the mixture, would not readily receive or diffuse the heat. This may account for the fact that the igniting temperature of 525° is never reached except from some external cause of heating, such as friction or attrition; but the smallest particle thus heated may explode any quantity. An invisible or black heat is quite sufficient to inflame this substance.

A singular fact was communicated to me by the late Mr. Scanlan in relation to an inflammable composition which is much used in theatres and pyrotechnics under the name of *Red-fire*. It consists of a mixture of chlorate of potash, charcoal, sulphur, sulphide of antimony, and nitrate of strontia. One of his friends

had placed a quantity of this powder in a store-room. On the following day, while this gentleman was in an adjoining apartment, it spontaneously ignited and was entirely consumed. The quantity which thus underwent spontaneous combustion is not stated, but neither before nor since has any instance of a similar kind been observed, although the substance is manufactured and used in large quantities. I find that a black heat (*i.e.* below 900°) is sufficient for the kindling of this substance.

Organic substances.—The most important questions on spontaneous combustion have arisen in reference to organic substances, chiefly of vegetable origin. It is unnecessary to refer to those accidents which occur from the admixture of strong nitric or sulphuric acid with straw, wool, or certain essential oils. The effects in such cases, if any, are generally immediate, and create no difficulty. In other cases, without contact with any chemical agents, certain substances—such as hay, cotton, and woody fibre generally, including tow, flax, hemp, jute, rags, leaves, spent tan, cocoa-nut fibre, straw in manure-heaps, &c.—when stacked in large quantities in a damp state, undergo a process of heating from simple oxidation (eremacausis) or fermentation, and after a time some of them may pass into a state of spontaneous combustion. Among these substances, hay and raw cotton in a damp state have been known to become ignited without any external source of ignition. With regard to the other substances, when stacked in a wet state under similar circumstances, it has been ascertained that they become heated so as to evolve copiously aqueous vapour; but, so far as I am aware, the heat has not reached a charring-point of 600°, or an igniting-point of 1160°. No smoke or smell of incipient combustion has been produced. One case is reported in which wet flax is said to have ignited spontaneously, and to have destroyed a ship and her cargo, but ignition from an external source was by no means excluded. ('Ann. d'Hygiène, 1841, 1, 359.)

It is within the experience of most persons that newly-stacked hay insufficiently dried becomes, after a few days, hot in the centre of the stack, and aqueous vapour or steam escapes: this is followed by smoke and a peculiar odour of partially-burnt vegetable matter, and, on examining the interior of the stack at this time, the hay will be found of a dark-brown colour, almost charred. At a still later period a thick smoke will issue, followed by ignition or kindling on exposure to the air. According to the testimony of shippers and merchants, raw cotton stacked in quantity, or packed in the hold of a ship before it is thoroughly dry, undergoes a similar series of changes, and is liable to become ignited by the access of air. It was probably owing to the spontaneous combustion of cotton that the merchant ship the 'Earl of Eldon' was destroyed by fire in 1834. I ascertained from the captain of the ship that the cotton which he had on board had been brought down to Bombay during the wet season—that no attempt was made to dry it properly before shipping it, and that in this state it was closely packed between decks, as well as in every spare part of the vessel. About a month after leaving the port, the crew were alarmed by an abundance of vapour issuing from the fore-hatchways. The vapour became more dense, and assumed the character of a thick smoke. Several bales of cotton were removed, but the danger became thereby increased, owing to the free current of air created, and in a very few hours the deck caught fire. The ship was then abandoned, and its total destruction speedily followed. I have since heard of several instances of a similar kind, but in some of them the theory of spontaneous combustion appears to have been too readily adopted. A ship laden with cotton is liable to destruction at all times by the careless use of fire—by candles, lucifer-matches, or the smoking of tobacco. It is scarcely possible, in such cases, to exclude entirely these accidental sources of external ignition; and to assign the accident to spontaneous combustion,

because no cause is apparent, is illogical. The materials causing the fire are consumed with the cargo. The person who has been carelessly or unconsciously the cause of the fire makes no statement, and the cause can therefore be only matter of conjecture.

Cotton impregnated with *oil*, when collected in large quantity under circumstances favourable for the retention of heat, is liable to spontaneous combustion. An accident of this kind occurred in New York in 1832, in which a ship and her cargo were entirely destroyed, from no other cause, so far as could be ascertained, than the spontaneous ignition of some bales of cotton on which oil had become accidentally spilt. M. Chevallier refers to other cases ('Ann. d'Hyg.' 1841, 1, 367). The accumulation of cotton-waste used in cleaning lamps and the oiled surfaces of machinery, has been also said to give rise to accidents of a similar kind. M. Chevallier reports the case of a man who was charged with setting fire to a house. The fire had occurred in two corners of the building at the same time—one on the ground floor, and the other on the second floor. A large quantity of cotton-waste had been placed on these two spots, and it was supposed these had been wilfully ignited. The person accused was fortunately able to prove an *alibi*, and he was acquitted. The cause of the fire remained inexplicable, until about six months afterwards. M. Chevallier in accidentally passing a factory saw a heap of a similar material burning in one corner of the yard; and on inquiry he found it to be cotton-waste which had spontaneously ignited, and had been removed from the factory to that spot in order to guard against fire. In his judgment and that of his co-experts, who were prepared to give their opinions against the man charged with incendiarism, the cause of the previous fire was thus satisfactorily explained. ('Ann. d'Hyg.' 1842, 1, 211.) In 1865 a case was tried at the Manchester Autumn Assizes (*Knowles* v. *North British Insurance Company*) involving a question of this kind. It was an action against the Company for 500*l*. on a policy insuring 'cotton-waste' against fire. The policy contained a clause that there should be no 'oily, greasy,' or dirty waste in the stock, and the defence was that there had been a breach of this stipulation. A fire had taken place from the heating of the waste, and some samples were produced and were proved to be oily or greasy. There was some difficulty in settling what was 'oily waste,' as it was contended all cotton was oily. The defendants contended that the clause applied to railway and foundry waste used in cleaning machinery which had been mixed with the stock. The common waste of cotton factories, although naturally oily, they did not object to. A verdict was returned in their favour. The oily waste put with cotton-waste had caused a fire by spontaneous combustion, destroying property to a large amount.

The admixture of *oil*, especially siccative or drying oil, with dry woody fibre of any kind, is more likely to give rise to heating and combustion than an admixture with water. The oil, besides more rapidly absorbing oxygen, is itself highly inflammable at a red-heat. Water is not only incombustible, but in a quantity of fifty per cent. renders woody fibre indestructible by fire, so long as it remains in the fibres or pores. A friend informed me that an instance had occurred within his knowledge where a fire took place in a druggist's shop by reason of a quantity of oil having been spilled on dry saw-dust. Vegetable substances boiled in oil furnish, according to M. Chevallier, a residue which is liable to spontaneous ignition. ('Ann. d'Hyg.' 1841, 1, 370.) In the opinion of this writer, all kinds of woollen articles imbued with oil and collected in a heap may inflame spontaneously. (Op. cit. p. 369.) Hemp, tow, or flax, similarly imbued with oil, may become heated and the temperature reach a degree to cause them to ignite spontaneously (p. 708). In the manufacture of floorcloth and sailcloth, mixtures of this kind are generally made, and the storage of these articles in close chambers under circumstances favour-

able to the retention of heat, may give rise to accidental combustion. For cases of this kind see 'Ann. d'Hyg.' 1841, 1, 373.

From some experiments made in Russia, it appears that a mixture of any drying oil with lampblack, in certain proportions, is liable to spontaneous ignition. The proportions most favourable for this were found to be about equal parts of lampblack and linseed-oil. In 1781 a fire broke out in a Russian frigate while lying in the harbour of Cronstadt. There had been no fire on board the vessel for five days. On tracing the source of the smoke, it was found to issue from the sailroom, and some of the sailcloth was in a state of combustion. A mixture of boiled oil and lampblack had been prepared for painting the vessel. It was believed that the contact of this with the hempen fibres had led to the accident. A similar mixture spread on cloth and laid aside in a hammock became heated, and took fire in about twenty hours on letting the air have access to it. (Op. cit. vol. 1, p. 384.)

Accidents from a similar cause are said to have occurred in France in the preparation of a balsam in which olive-oil was used with dry vegetable matter. In two cases the residue is said to have become hot, and to have given off a vapour having a strong smell of burnt grease. In one instance the mass became simply carbonized; in the other it became incandescent, and would have communicated flame to any combustible which might have been in contact with it. ('Journal de Chimie Médicale,' 1846, p. 672, and 1847, p. 558.) Although no cases are, so far as I know, recorded, it is probable that linen and cotton rags, paper, jute, and cocoa-nut fibre imbued with oil might undergo similar changes.

This subject has been lately investigated experimentally by Mr. Galletly ('Pharm. Jour.' Sept. 1872, p. 225.) A handful of cotton-waste was soaked in boiled linseed oil and afterwards wrung out and placed in a small box in a room at about 170°. A thermometer was passed through the corner of the box, with its bulb in the oily cotton. The mercury began to rise rapidly, and in an hour and a quarter the thermometer in the stem indicated 350°. Smoke issued from the box, and on exposing it to the air the cotton burst into flame. Treated in a similar manner with raw linseed oil the cotton burst into flame in four and five hours. With rape oil the cotton was reduced to ashes within ten hours. In these experiments a temperature of 170° was maintained in the room. In the following experiments the temperature of the room was lowered to 132°, the quantity of waste used being not more than the sixteenth of a cubic foot. With olive oil there was rapid combustion in five or six hours. With castor-oil the effect was more slow, the mass of cotton was only found to be charred on the second day. This oil undergoes oxidation very slowly. Lard oil produced rapid combustion in four hours. Sperm oil did not char the waste, but *seal* oil produced ignition in one hundred minutes.

It will be perceived from these results that animal oils, as well as vegetable oils, have this property, and that the conditions for combustion are that an oil should be present in the woody fibre, that the surrounding temperature should be high, and the material packed in a close form. The combustion of cotton under these circumstances may be calculated on, for any oil, with the same certainty as for any ordinary combustible. The term spontaneous is therefore objectionable. Mineral oils derived from coal and shale have no tendency whatever to produce heat when mixed with cotton, and an admixture of these with animal and vegetable oils was found to prevent the temperature from rising to the burning point.

There are no experiments to show that cotton-waste mixed with *water* instead of oil would produce any such effects as those above described.

Questions involving points of commercial law necessarily arise in reference to a variety of substances. In the case of *Koebel* v. *Saunders* (Common Pleas, Westminster, January 1865), an action was brought by plaintiff on a policy of

insurance on a cargo of cocoa-nut oil from Cochin to Marseilles. The casks of oil were stowed with cocoa-nuts, which were liable, if not dry, to heat and ferment. They did heat and ferment, and the staves of the casks so shrank therefrom that the hoops came off, and much of the oil escaped by leakage, while other portions were damaged. The plaintiff alleged that the heating of the cargo was occasioned by sea-water getting into the ship from bad weather, and causing the cocoa-nuts to ferment, and that the loss was occasioned by perils of the sea, and therefore that the insurers were liable. The defendant contended that the heating of the cocoa-nuts was a natural process, and that the fermentation began before there was any bad weather, and then went on, occasioning the loss, and that for the loss so caused they were not liable. A verdict was obtained by the plaintiff. Spontaneous combustion was not the question at issue in this case, although the leakage of oil was favourable for this occurrence.

Woody fibre impregnated with turpentine, according to the observation of the late Mr. Scanlan, is liable to spontaneous ignition. He communicated to me the following case, which he has elsewhere published ('Records of Science,' August 1835). In March 1835, a fire broke out in a turpentine distillery at Dublin. The fire was confined to what is termed by turpentine-distillers chipcake; and it could only be attributed, under these circumstances, to the act of an incendiary, or to the spontaneous ignition of this substance. The raw American turpentine, as it is imported, contains many impurities in the form of chips of wood, leaves, and leafstalks. These impurities are commonly separated by heating the turpentine to about 180°, and straining it: the mass thus separated (which is subsequently exposed to a temperature of 212°) is called chipcake: when thus obtained, it has not been known to undergo spontaneous combustion. On the occasion above mentioned, a new plan had been adopted by the manufacturer. The raw turpentine with its impurities was exposed at once to a temperature of about 250°, and the melted resin was then strained from the chips. The dry chipcake from this process was laid in a heap outside the still-house about three o'clock in the afternoon, and at midnight it was observed to be in flames. Mr. Scanlan found, in making his observations upon a portion of chipcake thus prepared, that the temperature gradually increased towards the centre of the heap, although on the exterior it was cold and brittle. In four hours a thermometer rose to 400°, and a large quantity of vapour, accompanied by a strong odour of pitch and resin, was extricated. The exposure of the mass experimented on took place at one o'clock in the afternoon, and although it rained hard during the night, at half-past seven the following morning it burst into a flame. Three other experiments were made with similar results: in the third, the porous heap appeared to become red-hot in the centre, so that the adhering resin melted and dropped from beneath. The ship 'Jane' was destroyed at sea in August 1851, apparently owing to the combustion of a material of this kind. She was bound from New York to Glasgow, with a cargo of tar in barrels, resin, and oil of turpentine. Two days after sailing, an alarm was raised, and on opening the hold, smoke appeared in quantity issuing from the midst of the cargo. Ship and cargo were entirely destroyed.

In January 1867 a ship, homeward bound from Calcutta, with a cargo consisting of jute, castor-oil, &c., was discovered to be on fire while off Portland. The ship was navigated into the Thames, and was there entirely consumed. The fire was attributed to some accident, by which the oil had come in contact with the jute.

The effect of *water* in promoting the heating and spontaneous combustion of vegetable substances appears to be far inferior to that of oil. With the exception of hay and cotton, I have met with no instance of the spontaneous

ignition of woody fibre as a result of its being simply wetted and exposed to air. The straw in manure-heaps, spent-tan, jute, flax, hemp, Esparto grass, cocoa-nut fibre, rags, and waste-paper wetted, are subject to a process of spontaneous heating, giving rise to the escape of aqueous vapour or steam; but I have not found any authentic instance in which this heat was proved to have reached the temperature necessary for combustion. Analogy tells both ways: for while cotton has thus ignited, spent-tan, which is in an equally favourable state for combustion, although collected in enormous heaps, has never been known to ignite spontaneously. In the manufacture of white lead, spent-tan is frequently piled up in large quantities under sheds. The mass becomes heated, and evolves aqueous vapour and carbonic acid. This heating, so far as I know, has never gone on to such a degree as to cause ignition. A friend who, in the course of business, has largely employed the finer portions of cocoa-nut fibre and dust, informs me that, when it was piled in large heaps in a damp state, he had observed that the temperature rose, and steam escaped from it; but he had never known it to reach the temperature of boiling water, and he had never heard of its igniting spontaneously.

The same may be said of flax, jute, and Esparto grass. In cases in which it is alleged that these substances have kindled spontaneously, careful inquiry has usually shown, or rendered it probable, that there was some external source of ignition, either from drying the substance by artificial heat or from a careless use of fire. In November 1872 a great fire took place in the City Flour Mills, Thames-street. The cause of the fire was a mystery. According to the evidence of Captain Shaw, of the London Fire Brigade, it broke out on a floor in which a number of sacks were piled. These sacks were frequently damp. He had heard of cases in which fires were described as being caused by the spontaneous combustion of sacks, but he did not know of any authentic instance of such an occurrence. He should have thought, if such were the case, that the smouldering must have been going on a day or two previously, and would have been preceded by a smell of burning. He found on examination that some of the sacks which had been recovered from the room in which the fire originated were burnt round the *outside* and not in the middle! It was also found that a number of idle persons were on the premises that afternoon, and that one of them, who had a box of lucifer-matches, was intoxicated. All denied smoking, or that the lucifers had been used.

It was clear from Captain Shaw's evidence that the fire had been applied to the sacks from without, and not, as in a haystack, by spontaneous heating within. The fire most probably arose from the careless use of tobacco or matches.

One circumstance appears to have been overlooked in reference to this subject. Assuming that there is more than the usual proportion of water in the fibre, the heat is not likely to reach the burning-point at or above 1000°, unless an enormous quantity of the material is accumulated in a stack or heap, or enclosed under cover, as in the hold of a ship, where there is no circulation of air. The material which thus piled up or stored would retain the heat and ignite, is rapidly cooled when spread out so as to expose a large surface to air, especially if it is frequently turned over. Hay is never known to ignite until it has been placed in a stack: if kept in the field in small heaps, and turned, it never becomes so heated as to pass into combustion. Thus the mode of storage is as important a condition as the presence of water. It is a fair inference from these facts that no substance liable to spontaneous heating acquires a temperature sufficient to create a risk of fire when it is opened out and freely exposed to air. To compare this condition of the material with the close package of cotton in the hold of a vessel, or of hay in a stack where there can be no ventilation, must necessarily lead to a wrong conclusion.

In the following case (*Hepburn* v. *Lordan*), which came before Vice-Chancellor Wood in January 1865, there was a material called *jute*, a vegetable fibre derived from the *Corchyrus capsularis*, resembling flax; there was water, and air, but the condition of stacking or storage in a confined space was wanting. The defendants had collected in an open yard in Bermondsey a quantity of jute, amounting to about three hundred tons. The jute in question was the salvage of a fire which had occurred on the 26th November 1864. Part of it was damaged by fire, and the whole of it was so thoroughly saturated with water as to render it unfit for commercial purposes. It was admitted on all sides that jute in a dry state, although very combustible when ignited, would not undergo spontaneous combustion; but it was contended for the plaintiff, who occupied a large leather factory adjoining, and who was heavily insured, that the damp jute was in a heated state, and there was imminent danger of its taking fire spontaneously. No evidence was adduced to show that under such conditions jute had ever been known to undergo spontaneous ignition, but reliance was placed on the analogous condition of cotton. On the part of the defendants, there was evidence from merchants and shippers, that although they had for about fifteen years imported the article from the East Indies largely, and had seen it brought down the Ganges in open boats in a wet state, they had never known it to undergo spontaneous combustion: it became heated, and then dried. The defendants' jute had been examined on the 4th January, sixteen days after it had been placed in the yard, and nearly six weeks after it had been wetted by water: one portion of the heap then felt hot to the hand, and in another part, at about a foot deep, the thermometer rose to 103°. Aqueous vapour issued from it in quantity in many parts. On these facts it was reported as dangerous, and liable to sudden and spontaneous ignition. I was requested, on the part of the defendants, to examine and report on the state of the jute. This examination was made on the 17th January, *i.e.* a fortnight later, with the following results. The jute was in scattered heaps of from four to seven feet in height, covering a very large area and exposing an extensive surface to the air: the quantity was then stated to be from 250 to 300 tons. Aqueous vapour issued from it in several parts, and other portions evolved vapour when turned over. A number of observations were made with thermometers, in various parts of the jute and at different depths. The temperature of the air was then about 45°. In six observations at from 18 to 24 inches below the surface, the temperature varied from 67° to 85°. The thickest portion of the heap, at a foot and a half below the surface, had a temperature of 125°; at two feet, of 133°; at three feet, of 140°; at four feet, of 130°; at five feet, of 128°; and at six feet, *i.e.* within one foot of the ground, of 117°. The temperature thus increased as the centre was approached, and decreased equally upwards and downwards. Thin slips of fusible metal, melting below 212°, were employed as a test, but this compound was not melted in two of the hottest parts examined. It was therefore clear that no part of the jute had reached within 70° the temperature of boiling water, although it had been nearly a month on these premises, and seven weeks had elapsed since it was first damaged by water. The aqueous vapour which escaped from the hottest portion (at 140°) was unmixed with smoke or any of the products usually evolved from bodies in a state of torrefaction or incipient combustion. The vapour was simply that of water derived from the jute, which was still sodden, and there was a faint trace of carbonic acid in 100 cubic inches. The jute presented no appearance of charring in any part, except where it had suffered from the fire in November.

A portion of the jute from this the hottest part was found on analysis to contain 50 per cent. of water. It could not be made to burn in a strong gas-flame; and a red-hot bar of iron passed over it, merely charred it at the spot

touched without inflaming it. The jute, which was being carted away as dry, was found to contain 16 per cent. of water. This could be ignited in a gas-flame, and readily burned when touched with a bar of iron at a red-heat. On these facts, and considering—1st, that this jute had been exposed to air over a very large area, for at least a month, without acquiring the heat of boiling water, while its ignition when dry does not take place below a temperature of 1000°; 2ndly, that it then contained half its weight of water, which rendered it incombustible when flame and a red-heat were directly applied to it; 3rdly, that there was no odour of torrefaction or charring, and that no products of the ordinary combustion of woody fibre were present in the vapour which escaped from the centre of the heap; 4thly, that the maximum thickness of the heap was not more than seven feet; 5thly, that the whole of it was turned over twice a week to ensure more rapid drying; and 6thly, that as it dried and became combustible it was removed from the premises daily—I came to the conclusion that there was no danger of spontaneous combustion under the conditions in which this jute was placed. The Vice-Chancellor granted an injunction on the ground not of spontaneous combustion, but of the danger of external ignition.

Many fires, including the great fire at London Bridge in 1861, have been referred to the spontaneous combustion of jute in its ordinary state; but that this substance should bear a long sea-passage from the East Indies without manifesting any signs of combustion, and should only take fire from the alleged cause many weeks or months after it had been deposited in an English warehouse, is wholly incredible. In all the fires yet known where this substance has been burnt, ignition from external causes, if not proved, was highly probable. At any rate, should the external cause not be at once discovered, or should it be considered inadequate, this is no reason for assuming that the substance has spontaneously taken fire, either in the wet or dry state. Such loose reasoning as this would equally show that the human body was spontaneously combustible.

Considering that this subject involves life and property to an enormous extent, it is to be regretted that there is a want of accordance in scientific opinions. These cases hardly admit of experiments on a sufficient scale at the hands of scientific men. The material must necessarily be employed in enormous quantities, and stacked or disposed under circumstances not open to experimentalists—hence in framing their opinions they can only be guided by the facts hitherto known and recorded. Those facts, so far as they are at present known, are adverse to the theory that wet woody fibre, if we except raw cotton, can become so heated as to ignite spontaneously. Even with regard to cotton more accurate observations are required. The great fires in the Liverpool dock-warehouses some years since were ascribed to the spontaneous combustion of cotton; but external ignition from gas, the smoking of tobacco, or the use of lucifer-matches was highly probable, and never completely excluded by the evidence. Here again it is to be considered why it is that cargoes of cotton should traverse the ocean only to become spontaneously ignited after being stored in English warehouses, when the hold of a vessel is far more favourable to ignition from this cause. The spontaneous combustion of recently-cut hay is observed either soon after it has been stacked or not at all: it is always distinctly indicated by the odour of torrefaction some time before ignition occurs. So far as I know, no one has witnessed the spontaneous combustion of hay, after it has been once dried, when removed and stored in another locality; and yet this is just as probable as that dry Indian or American cotton or jute should ignite in our warehouses without the direct application of fire.

It is stated by those who have extensive commercial relations with articles of which woody fibre is the basis, that if the substance is once thoroughly

dried, the subsequent addition of water to it may cause it to heat, but not to ignite. Spontaneous ignition is observed only in certain fibres in the green state. On this point further information, however, is required. Saturation with water after drying tends to operate chiefly by causing decay or rotting of the fibre. Large quantities of *Esparto grass* are now imported into England for the manufacture of paper. It is generally in a dry state like jute, and is, therefore, not liable to fermentation or spontaneous combustion. An accident of this kind is however reported to have occurred in the Tyne docks in 1871. One of the warehouses, filled with some hundreds of tons of Esparto, was found to be on fire, and the whole was destroyed. It was ascribed to spontaneous combustion, but it might with greater probability have been ascribed to the use of tobacco or lucifer-matches.

In watching these changes in vegetable matter on a small scale, we may form a conjecture of what happens in large masses, as well as of the source of the heat which sets free aqueous vapour, and creates alarm by its being mistaken for the smoke of combustion. I placed in stoppered bottles, at a temperature of 60°, jute, withered oak-leaves, partially decayed sawdust, and cocoa-nut fibre, wetted. In forty-eight hours, in each case, the oxygen of the air had been sufficiently removed from each bottle to lead to the immediate extinction of a burning taper, and this gas had been replaced by carbonic acid. The vegetable matter had lost carbon, and the air in contact with it, oxygen. Such changes could not take place without the production of heat, although in operating on such small quantities, the increase of temperature did not admit of measurement.

In a large heap this process of oxidation goes on on a larger scale, and the heat manifests itself not merely by the rising of the thermometer, but by the production of a much larger quantity of aqueous vapour. The greater proportion of the heat is no doubt carried off by the vapour; that which remains is rendered sensible in the mass by the non-conducting nature of the material. A free exposure to air by a frequent change of surface tends to keep down this temperature, and thus to prevent its rising even to the torrefying point of 500° or 600°.

These remarks apply equally to manure-heaps, which always contain a large proportion of vegetable fibre in the form of straw as well as excrement. These heaps become so hot as to evolve much steam; but although the dry materials are perfectly combustible, the manure does not spontaneously ignite. In this case there is putrefaction of animal substance as well as fermentation and decay (eremacausis) of vegetable matters; but as both processes lead to the production of heat, this cannot affect the result. Oxygen is always necessary to decay or eremacausis. It is absorbed by decaying bodies, and the result is a slow combustion, applying this term in the wide meaning assigned to it by Liebig ('Organic Chemistry,' p. 230.) Decay is simple oxidation; fermentation implies spontaneous changes in organic substances in which gaseous products without odour are evolved; putrefaction, on the other hand, implies the spontaneous decomposition of organic substances which emit gases of a disagreeable smell. Oxidation, however, goes on in some cases of fermentation, as well as in putrefaction, and heat is evolved in a proportionate degree. In a manure-heap oxygen is only slowly absorbed—the heat never reaches a high degree; and a large portion of it is carried off as it is produced, by the aqueous vapour into which it converts the water of the organic compounds.

The decay or eremacausis of vegetable substances is a decomposition analogous to the putrefaction of azotized bodies (Liebig); and, according to the same authority, all putrefying bodies pass into the state of decay when exposed freely to the air, and all decaying matters into that of putrefaction when air is excluded (Op. cit. p. 270). No absolute distinction can be drawn; the carbon

is converted into carbonic acid by oxidation in decay and putrefaction, and a proportionate amount of heat is evolved.

Azotized substances—or those organic matters, whether vegetable or animal, which contain nitrogen—are liable to fermentation; but it is not usual to hear of the heat reaching the kindling-point. Damp *corn*, *barley*, or *oats* will ferment and become heated. MM. Chevallier, Ollivier, and Devergie were consulted in a case in which a barn containing a quantity of oats had been destroyed by fire. It was supposed by the proprietor to have been an act of incendiarism; but M. Chevallier and the other experts drew the conclusion from the whole of the facts, that it was the result of spontaneous combustion from the fermentation of the grain which had been stored in the barn in a damp state ('Ann. d'Hyg.' 1841, 1, 309). The grounds for this opinion were based chiefly on the facts—1st, that the oats were proved to have been stored in the barn in a damp state; 2ndly, that the middle portion of a large pile of sheaves was blackened and charred, while the outside had preserved its natural colour and appearance; 3rdly, that some of the sheaves which on the day before the fire, had been removed to another building, for threshing, presented the same carbonized appearance and colour; and 4thly, that for some days previously the labourers had perceived that the oats were so hot as to alarm them. The length of time which the oats had been in the barn is not stated, but the facts above mentioned were such as to be consistent with the theory of spontaneous combustion. It is obvious that all such cases require a very close and, indeed, exhaustive process of inquiry before the results are assigned to this cause. The destruction of corn by fire in barns and stacks is frequent enough in this country, but it is generally traceable to the acts of incendiaries. Spontaneous combustion has not been raised as a defence, because, probably, all the proved circumstances were adverse, and there were no facts to support the theory. The storage of damp corn, fodder, hay, &c. in barns, is in Chevallier's opinion not an unfrequent source of fire as a result of heating and spontaneous ignition (Op. cit. pp. 321, 323); and he believes that acts of incendiarism are often wrongly imputed, when the facts would admit of explanation by reference to this theory. On the other hand, there are cases of incendiarism which, unless the facts were all known, might be wrongly imputed to spontaneous combustion. I was once present at the Chelmsford Assizes at the trial of two men for arson. They had attempted to burn down a barn containing sheaves of corn. From an examination of the premises it was clear that no one had broken into the barn, and no light had been used by the labourers. The sheaves of corn stacked about the centre of the barn were found only partially burnt: the fire had not spread to other sheaves, owing to an intervening space. The evidence showed that part of a plank had been torn off from the outside of the barn, near the ground, and that some lighted matches had been introduced through this hole from the outside upon the chance of firing the corn stacked within. Some of the coloured matches entire and some partly burnt, with the torn half of the sandpaper bottom of a match-box, were picked up near the hole. The two men who were arrested were found to have similarly coloured matches about them, and in the pocket of one was found the other half of the sandpaper of the box. The torn portions exactly fitted, and completed the bottom of the box. But for the accidental stoppage of the fire and the discovery of some unburnt matches, it might have been plausibly contended that this was a case of spontaneous combustion.

In these cases there would probably be true fermentation, the gluten in the vegetable juices operating as a ferment. The process of malting is a familiar instance of the fermentation of barley. The wet grain becomes spontaneously heated by exposure to air; carbonic acid and aqueous vapour are given off, and the constituents of the seed undergo certain chemical changes. So far as

I know, grain in malting has never acquired a sufficient temperature even to torrefy itself, much less to ignite spontaneously. Chevallier thinks it may take fire spontaneously after it has been dried, but he adduces no case to support this opinion (Op. cit. 375). There are but few instances reported in which animal substances like hair, wool or silk, are said to have undergone spontaneous combustion. In April 1867, a ship from Australia, laden with three thousand bales of *wool*, arrived at Plymouth in distress. For two days previously, it had been discovered that the wool in the hold was burning, and this was attributed to spontaneous combustion. With respect to silk, it is stated that black-dyed silk accumulated in quantity, is liable to undergo spontaneous combustion. A fire at a silk-mercer's in Paris is said to have been traced to this in 1870. Persoz endeavoured to find the cause, but could not discover it. He came to the conclusion that the phenomenon was only likely to occur when the black-dyed silk was very dry and stacked in large quantity ('Chemical News,' 1870, 2, 145).

In freshly-cut *hay*, the vegetable juices contain azotized or nitrogenous principles, which, as in grain, may pass through a stage of fermentation. If stacked early in large quantity, this fermentation will notoriously lead to the production of a high temperature, charring, and spontaneous ignition on the admission of air. Although commonly treated as similar cases, the chemical conditions are different from those which are met with in dried woody fibre (such as flax, jute, or straw) wetted with water. There is no ferment in these cases—the process is simply one of oxidation, and the heating does not go beyond the temperature of boiling water, even if it reaches this.

The spontaneous combustion of vegetable matter has been frequently admitted upon insufficient evidence. Chevallier enumerates, among other substances as being liable to this accident, decayed leaves collected in forests, manure-heaps, and the pulp of potatoes; but as some of the instances adduced date as far back as 1758, and no recent cases have occurred, the statements must be considered as untrustworthy. (Op. cit. pp. 356, 362.) The 'Journal de Chimie Médicale,' of which he is editor, contains the reports of only two instances of the spontaneous combustion of vegetable matter during a period of twenty years (see p. 715). There can be no doubt that large heaps of wet leaves undergo a process of heating which has been elsewhere described as oxidation or rotting (p. 720), but no one has ever observed them to reach a temperature of actual ignition. In reference to tobacco-leaves, which during manufacture undergo fermentation, Chevallier furnishes an answer to these loose statements regarding spontaneous combustion. When the dried leaves of tobacco are moistened with water, tied in small bundles, and then heaped together, fermentation soon commences in them; oxygen is absorbed, the leaves become warm, and emit the peculiar smell of tobacco and snuff. If too high a temperature is avoided, the smell increases and becomes more delicate. According to Liebig, the powerful poison *Nicotina* is the product of this fermentation ('Organic Chemistry,' p. 291). In making inquiries in the French tobacco-factories, Chevallier found that in the double fermentation of the leaves, there was no instance recorded in which they had ever undergone spontaneous ignition. The temperature which the piles of leaves acquired did not exceed 170° (Op. cit. p. 363). This, among other facts, tends to show that the spontaneous heating of a substance may take place without necessarily advancing to the very high temperature required for its combustion.

Dry wood is supposed to have the property of igniting spontaneously. Deal which has been dried, by contact or contiguity with flues or iron-pipes conveying hot water or steam at 212°, is supposed to be in a condition for readily bursting into flame when air gets access to it. The destruction of the Houses of Parliament, and numerous fires in public and private buildings, have been

assigned to this cause. Wood which has decayed, and is then dried in an oven or by a fire, is as inflammable as a pyrophorus, according to Chevallier (Op. cit. p. 276). That pine or other resinous wood which has been for a long time in contact with bodies having a temperature of from 100° to 300° should lose all its water and become highly combustible, like dry flax or jute, is no doubt true. That it should ever acquire the property of taking fire below its igniting temperature in air (1000°) is unproved and untrue, so far as we can speak from experience. That it should ever reach this burning temperature spontaneously, and without contact with air, brick, or metal heated to 1000° or upwards, is a view unsupported by any known facts. I have exposed the thinnest deal shavings in contact with iron pipes at a temperature varying from 150° to 200° for some weeks without producing combustion, torrefaction, or any change indicative of an approach to either condition. In the patent desiccating process for timber I have seen joists and beams exposed for many days to a temperature of from 200° to 300° in heated air without combustion. The most inflammable deal may be plunged into melted lead at 620°, and zinc at 770°, and retained there without igniting. The wood is simply charred where it touches the molten metal, but does not burn. In the accidents said to have arisen from dried wood in or near flues, combustion could only have taken place as a result of a sufficiently high temperature (1000°) applied from without. This may be communicated by a current of hot air, as well as by flame, by bricks or metal heated to redness, but by no heat short of this. The dried wood is in a condition to burn fiercely, but not to ignite spontaneously; or no dwelling-house, locomotive, or steam-vessel would be safe for a single day. The bad construction of flues is the cause of these accidents, and not the spontaneous ignition of wood which has undergone a process of drying by warm air. In a paper by Chevallier in the 'Annales d'Hygiène' (1843, 1, p. 99), various instances of supposed spontaneous combustion are referred to, including cases in which the ignition of combustible substances was caused by the friction of wheels or machinery.

END OF THE FIRST VOLUME.

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